

Final First Five-Year Review

PREPARED FOR

Luke Air Force Base, Arizona

Final First Five-Year Review

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List of Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMSL	Above Mean Sea Level
AWQS	Aquifer Water Quality Standard
BEP	Bis (2-Ethyl Hexyl) Phthalate
BGS	Below Ground Surface
BGP	Base General Plan
BNA	Base/Neutral and Acid Extractable Organic Compound
BTEX	Bezene, Toluene, Ethylbinzene, Total Xylene
BX	Base Exchange
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Federal Code of Regulations
COC	Constituents of Concern
COEC	Constituents of Ecological Concern
COPC	Constituents of Potential Concern
DBCP	1,2-dibromo-3-chloropropane
DCA	1,2-dichloroethane
DCP	Dichloropropane
DOD	Department of Defense
DPDO	Defense Property Disposal Office
DRO	Diesel – Range Organics
DEUR	Declaration of Environmental Use Restriction
ECC	Environmental Chemical Corporation
EI	Ecological Inventory
ELCR	Excess Lifetime Cancer Risk
EPA	Environmental Protection Agency
FCOR	Final Close Out Report
FCOR	Final Closeout Report
FFA	Federal Facilities Agreement
FS	Feasibility Study
GWNT	Groundwater Not Threatened
GPL	Groundwater Protection Level
HDPE	High Density Polyethylene
HI	Hazard Index
HQ	Hazard Index
HRS	Hazard Ranking System
ICE	Internal Combustion Engine
ICP	Institutional Control Plan
IEUBK	Integrated Exposure Uptake Biokinetic
IRP	Installation Restoration Program
LCU	Lower Conglomerate Unit
LTM	Long Term Monitoring

LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminant Level
MFU	Middle Fine Unit
NCP	National Contingency Plan
NPL	National Properties List
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls Chromium
PCE	Tetrachloroethane
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PSC	Potential Source of Contamination
QA/QC	Quality Control and Assurance
OU	Operable Unit
RCRA	Resource Conservation and Recovery Act
RCVA	Resource Conservation Recovery Act
RFA	Facility Assessment
RFI	Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Super fund Amendments and Reauthorization Act
SRL	Soil Remediation Level
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
UAU	Upper Alluvial Unit
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UTL	Upper Threshold Limit
VEMUR	Voluntary Environmental Mitigation Use Restriction
VES	Vapor Extraction System
VOC	Volatile Organic Compound
WSRV	West Salt River Valley
WWTP	Waste Water Treatment Plant

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Executive Summary

In 1990, the United States Environmental Protection Agency (USEPA) placed Luke Air Force Base (Luke AFB) on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as Superfund) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Luke AFB (the site) was added to the NPL as a result of past hazardous material handling and disposal practices.

This five-year review was conducted pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Section 121(c), 42 U.S.C. § 9621(c), the National Contingency Plan (NCP) (40 CFR § 300.430 (f)(4)(ii)), Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P Final. This report summarizes the remedial actions and data collected since the beginning of the project in August 1990 through November 2001 and provides an evaluation of the effectiveness of the remedial actions relative to remedial objectives and to verify that remedial actions remain protective of human health and the environment.

Luke AFB, which is an advanced fighter pilot training institution, covers approximately 4,000 acres west of the Phoenix metropolitan area in Glendale, Arizona. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. The results of these activities generated potentially hazardous wastes such as petroleum residues, cleaning solvents, and other related wastes.

Subsequent to the listing of Luke AFB, remedial investigation/feasibility studies were performed to determine the nature and extent of contamination. A total of 33 potential sources of contamination (PSCs) were initially identified for investigation purposes. To aid in the management of the investigations, the PSCs were divided into two operable units, OU-1 and OU-2. OU-2, the first to be investigated, included the investigation of soils at eight sites at which only petroleum-related wastes were disposed. OU-2 PSCs include the following:

- PSC OT-04 Old Perimeter Road POL Waste Site
- PSC DP-05 POL Waste Disposal Trench
- PSC FT-06 South Fire Training Area
- PSC FT-07W Western Portion of the North Fire Training Area
- PSC ST-18 Facility 993
- PSC DP-22 POL Trench at Northeast Runway
- PSC DP-23 Old Surface Impoundment West of Facility 999
- PSC SD-40 Taxiway Discharge Area

OU-1 included the investigation of the soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. OU-1 PSCs include the following:

- Old Incinerator Site (PSC OT-01).
- Wastewater Treatment Annex Landfill (PSC RW-02).
- Outboard Runway Landfill (PSC LF-03).
- Eastern Portion of North Fire Training Area (PSC FT-07E).
- F-15 Burial Site (PSC OT-08).
- Canberra Burial Site (PSC OT-09).
- Concrete Rubble Burial Site (PSC OT-10).
- Former Outside Transformer Storage (PSC SS-11).
- Old Explosive Ordnance Division (EOD) Burial Site (PSC OT-12).
- Drainage Ditch Disposal Area (PSC DP-13).
- Old Salvage Yard Burial Site (PSC LF-14).
- Facility 328 Spill Site (PSC SS-15).
- Facility 321 Underground Storage Tank (UST) (PSC SS-16).
- Former Defense Property Disposal Office (DPDO) Yard (PSC SS-17).
- Base Exchange (BX) Leaking USTs (PSC ST-19).
- Oil/Water Separator Canal and Earth Fissures (PSC SD-20).
- Sewage Treatment Plant Effluent Canal (PSC SD-21).
- Base Ammunition Storage Area (PSC DP-24).
- Northwest Landfill (PSC LF-25).
- Hush House Canal (PSC SD-26).
- Northeast Landfill (PSC LF-37).
- Southwest Oil/Water Separator at the Auto Hobby Shop (SD-38).
- Waste Discharge at the Old Lockheed Site (SD-39).
- Skeet Range (OT-41).
- Bulk Fuels Storage (SS-42).

A more detailed description and background information for OU-1 and OU-2 PSCs is in Appendix A. It is important to note that PSCs 27 through 36 do not exist because there was a break in the numbering between PSC SD-26 and PSC LF-37.

In addition to the investigation of identified PSCs, a RCRA facility assessment (RFA) and RCRA facility investigation (RFI) were conducted to determine if any of the current operational facilities at Luke AFB should be included as PSCs in the CERCLA program. Remedial alternatives were identified, and remedial actions were designed and implemented as part of clean up activities.

As part of the OU-1 Feasibility Study (FS), a risk-based assessment was performed regarding acceptability of PSCs for residential land use given current conditions. Residential land use implies that a site can be developed and used for any purpose, including residential development. If a PSC was deemed unsuitable for residential land use, remedial alternatives were developed for that site.

Remedial alternatives were also developed for any site that could potentially impact underlying groundwater resources in the future.

Potentially exposed populations considered in the risk assessment included the following:

- Base workers
- Excavation workers
- Military personnel
- Child visitors for sites which extend off the base property
- Base residents

The risk assessment considered both average and reasonable maximum exposure conditions to characterize current and future risks.

Risk from residential exposure to combined surface and subsurface soil were calculated using both the USEPA Region IX PRGs and the ADEQ SRLs. Based on the results of the evaluation, all of the PSC areas evaluated were determined to be suitable for unrestricted, or residential land use with the exception of the following PSCs:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- ST-18
- LF-25
- DP-23 N
- SD-38

In addition to evaluating potential human exposure at Luke AFB, an ecological risk assessment was also performed.

This five-year review report provides a historical and five-year review process summary for OU-1 and OU-2 PSCs for which remedies were selected. These PSCs include the following:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14

- ST-18
- DP-23
- LF-25
- SD-38
- SS-42

The historical review and evaluation process also includes PSCs for which it was determined no action was required. These PSCs include the following:

- OT-01
- OT-04
- DP-05
- FT-06
- FT-07 W
- OT-08
- OT-09
- OT-10
- SS-15
- SS-16
- SS-19
- DP-22
- SD-21
- DP-24
- SD-26
- LF-37
- SD-39
- SD-40
- OT-41

The five-year review process primarily consisted of a site inspection, interviews and a review of relevant documents and data. Jeff Rothrock of Luke AFB led the five-year review for the site. The following team members assisted in the review:

- Jeff Rothrock, Luke AFB
- Jon Sherrill, ARCADIS G&M, Inc.
- Kent Lang, ARCADIS G&M, Inc.
- Stephanie Armijo, ARCADIS G&M, Inc.
- Monique Ostemann, USACE
- Greg Mellema, USACE

- Dan Stralka, USEPA
- Nancy Lou Minkler, ADEQ

The five-year review process includes the following primary elements:

- Remedy selection and implementation is reviewed and summarized for each OU-1 and OU-2 PSC for which a remedy was selected.
- Changes in standards were evaluated with respect to the continued effectiveness of the remedies that were implemented based on cancer risks and non-cancer hazards for applicable constituents of concern (COCs) for base worker or excavation worker scenarios.
- Groundwater monitoring results are compared to groundwater standards established for the project.
- Representatives of Luke AFB, USEPA, US Army Corps. of Engineers, ADEQ and ARCADIS G&M performed a site inspection of each PSC for which a remedy was selected on May 22, 2001.
- The results of interviews with individuals knowledgeable about the project.

OU-1 PSCs for which remedies were selected based on the results of risk assessment include the following:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- LF-25
- SD-38
- SS-42

For OU-1 PSCs, PRGs were not established. Alternatively, PSC specific cancer risks and non-cancer hazards were calculated using 1996 USEPA Region IX PRG guidance to develop a site-specific industrial scenario. To evaluate changes in standards as part of this five-year review, cancer risk and non-cancer hazards were recalculated using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable. ADEQ SRLs were also reviewed since they were used to determine risk under a residential land use scenario.

Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of 1×10^{-6} to 1×10^{-4} .

OU-2 PSCs for which remedies were selected based on the results of risk assessment include the following:

- ST-18
- DP-23

For OU-2 PSCs, 1991 USEPA Region IX PRGs were originally used to establish performance standards. To evaluate changes in standards as part of this five-year review, cancer risks and non-cancer hazards were recalculated for each COC using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable. The analysis of standard changes also included a review of 1996 USEPA industrial PRGs. ADEQ SRLs were also reviewed since they were used to evaluate residential use standards. Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of 1×10^{-6} to 1×10^{-4} .

The comparison indicates that PSCs for which changes in standards were evaluated are still within the acceptable risk range. It was concluded that selected remedies are protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled with the following exceptions:

- The northern portion of PSC DP-23 is within the acceptable risk range for industrial or non-residential land use, but outside the risk range for residential land use.
- The remedy at PSC ST-18 Facility 993 currently protects human health and the environment because the cap prevents exposure in the short term. However, in order for the remedy to be protective in the long term, a (Declaration of Environmental Use Restriction) DEUR is needed at the site to ensure long-term protectiveness.

A DEUR for PSC ST-18 and the northern portion of DP-23 has been filed with the ADEQ to resolve these issues.

A comparison of exposure point concentrations in groundwater (maximum concentrations for the period of record) and USEPA Region IX 2000 PRGs for tap water and ADEQ aquifer water quality standards were evaluated for the following PSCs:

- RW-02
- DP-05
- FT-06
- FT-07
- ST-18
- SD-20
- SD-21
- SD-38
- SS-42

The comparison indicates that exposure to groundwater results in risk that are within the acceptable risk range for these PSCs. A review of groundwater data for the period of record indicates that groundwater at Luke AFB is not impacted as there are no constituents in groundwater that currently exceed applicable water quality standards. All potential sources of constituents have been controlled or eliminated through the institution of pollution prevention measures or remedial activities

The following individuals were solicited for interviews by questionnaire as part of this five-year review:

- Belle Matthews, Luke AFB Project Manager
- Sean Hogan, EPA Project Manager
- Nancy Lou Minkler, ADEQ Project Manager
- Dan Salzler, Citizens Advisory Board (CAB) Community Co-Chairperson
- Joyce Clark, CAB member
- Martin Jeffries, CAB member

In addition to solicitation of interviews by questionnaire, the following individuals were interviewed in person as part of the five-year review site inspection:

- Chris Christoffer, Luke AFB Environmental Analyst
- Sergeant Anthony Michels, Luke AFB Infrastructure Superintendent

Chris Christoffer and Sergeant Michels were interviewed relative to procedures that ensure compliance with the Base General Plan (BGP) and Institutional Control Plan (ICP). As part of these interviews, the BGP was reviewed and it was verified that the ICP had been implemented. Also verified were approval and record keeping procedures for digging permits relative to environmental constraints at Luke AFB.

Luke AFB Five-Year Review Signature Cover Preliminary Information

Site name: Luke Air Force Base		EPA ID: AZ0570024133
Region: 09	State: Arizona	City/County: Luke AFB/Maricopa
LTRA* (highlight)		Construction completion date: December 17, 1999
Fund/PRP Lead: Luke AFB		NPL status: Final
Lead agency: USEPA Region IX		
Who conducted the review (EPA Region, state, Federal agencies or contractor): USEPA Region IX, ADEQ, USACE, ARCADIS G&M, Inc.		
Dates review conducted: From: April 2001 through December 2001		Date(s) of site visit: May 22, 2001
Whether first or successive review: First		
Circle: Regional Discretion	Due date: January 21, 2002	
Trigger for this review: Final closeout process (2000-2001) and time that has lapsed since finalization of the <i>OU-2 Record of Decision (ROD) in January 1994</i>		
Recycling, reuse, redevelopment site (highlight): N/A		

Issues: Northern portion of PSC DP-23 not remediated to residential soil standards and requires deed restriction. PSC ST-18 requires deed restriction to prevent future removal of cap and excavation of soil. Continued monitoring at specific PSCs to confirm protectiveness of remedies.

Recommendations: Declaration of Environmental Use Restrictions (DEURs) for PSC ST-18 and DP-23 has been filed with ADEQ (filed in 2001). Continued monitoring of groundwater will be conducted for PSCs RW-02, FT-07, ST-18, SD-20 and SS-42 as part of future five-year reviews.

Protectiveness Statement(s): The remedies at Luke AFB are protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled through implementation of remediation, institutional controls and monitoring.

Other Comments: None

Signature of Luke AFB Environmental Protection Committee Chairman

DENNIS A. REA, Colonel, USAF
Vice Commander, 56 FW

Date

1.0 Introduction

In 1990, the United States Environmental Protection Agency (USEPA) placed Luke Air Force Base (Luke AFB) on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as Superfund) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Luke AFB (the site) was added to the NPL as a result of past hazardous material handling and disposal practices. The location of the site is shown in Figure 1-1. On behalf of the United States Air Force, ARCADIS G&M, Inc. (ARCADIS G&M) has prepared this final first five-year review of remedial actions at Luke AFB, Arizona.

This five-year review was conducted pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Section 121(c), 42 U.S.C. § 9621(c), the National Contingency Plan (NCP) (40 CFR § 300.430 (f)(4)(ii)), Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P Final.

1.1 Background

The following sections provide a general overview of site conditions, and project history. This information is intended to give the reader of the final first five-year review report for Luke AFB adequate background information with which to evaluate current conditions at the site.

1.1.1 Physical Characteristics

Luke AFB, which is an advanced fighter pilot training institution, covers approximately 4,000 acres west of the Phoenix metropolitan area in Glendale, Arizona. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. Luke AFB lies in the Salt River Valley (SRV), which lies within the Basin and Range physiographic province. Elevations at Luke AFB range from 1,250-feet above mean sea level (amsl) at the northwest corner to 995-feet amsl at the southeast corner. The climate at Luke AFB is characterized as a desert climate. Rainfall at Luke AFB averages about 7.7 inches per year.

1.1.2 Land and Resource Use

The eastern portion of Luke AFB currently consists of a variety of light industrial facilities, office buildings occupied by administrative and community services, base barracks, and outdoor recreation centers. The central and western portions of Luke AFB include the runways, open spaces, and aircraft operations, training and maintenance facilities. Base residential housing and commercial areas are located east of the fenced areas of the main portions Luke AFB. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. The results of these activities generated potentially hazardous wastes such as petroleum residues, cleaning solvents, and other related wastes.

1.1.3 Project History

Subsequent to the listing of Luke AFB on the NPL, remedial investigation/feasibility studies were performed to determine the nature and extent of contamination. Remedial alternatives were identified, and remedial actions were designed and implemented as part of clean up activities. A record of the remedial actions implemented and how cleanup was accomplished at Luke AFB are summarized in the Remedial Action Report. The following is a background summary relative to the Superfund project at Luke AFB:

- Prior to 1976 and the Resource Recovery and Conservation Act (RCRA), potentially hazardous wastes, such as petroleum residues, cleaning solvents, and other related materials, were disposed on Base through fire department training exercises, road oiling for dust suppression, and in shallow trenches.
- In 1981, the Department of Defense (DOD) initiated the IRP to investigate and remediate past hazardous materials handling and disposal practices at all military institutions.
- Before the passage of SARA, the USEPA did not supervise the IRP program at Luke AFB. Subsequent to the passage of SARA, the USEPA was required to establish and maintain a docket of potentially contaminated federal facilities, perform Hazard Ranking System (HRS) scoring on these facilities, and list those facilities exceeding the HRS threshold score on the NPL.

- The USEPA audited Luke AFB in 1987, and scored the institution using the HRS.
- Because the Luke AFB HRS score of 37.93 exceeded the threshold value of 28.5, the USEPA added Luke AFB to the NPL in August 1990.
- On September 27, 1990, the USEPA, Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), and the United States Air Force (USAF) signed a FFA to establish the procedural framework for conducting the required environmental investigations at Luke AFB.
- Environmental investigations at Luke AFB were implemented in accordance with regulations established in the NCP at Title 4, part 300 of the Federal Code of Regulations (CFR).

Based on the results of the Installation Restoration Program (IRP) and other information compiled during the initial planning stages, the Federal Facilities Agreement (FFA) identified 33 potential sources of contamination (PSCs). To aid in the management of the investigations, the FFA parties divided the PSCs into two operable units (OU). OU-1 included the investigation of the soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. OU-2 included the investigation of soils at eight sites at which only petroleum-related wastes were disposed. The FFA created this special grouping to put the eight OU-2 sites on a “fast-track;” the idea being that sites with common wastes would allow for a timely investigation and cleanup. The eight OU-2 PSCs are listed below. The location of PSCs in OU-2 is in Figure 1-2.

- PSC OT-04 Old Perimeter Road POL Waste Site
- PSC DP-05 POL Waste Disposal Trench
- PSC FT-06 South Fire Training Area
- PSC FT-07W Western Portion of the North Fire Training Area
- PSC ST-18 Facility 993
- PSC DP-22 POL Trench at Northeast Runway
- PSC DP-23 Old Surface Impoundment West of Facility 999
- PSC SD-40 Taxiway Discharge Area

OU-1 was the last of two operable units to be addressed at Luke AFB and was defined to govern the investigation and potential remediation of air, surface water, and

groundwater resources Base-wide. In addition, the soils at 25 PSCs believed to have been impacted primarily by non-petroleum related wastes were included in OU-1. The 25 PSCs included in OU-1 are listed below. The location of PSCs in OU-1 is in Figure 1-3.

- Old Incinerator Site (PSC OT-01).
- Wastewater Treatment Annex Landfill (PSC RW-02).
- Outboard Runway Landfill (PSC LF-03).
- Eastern Portion of North Fire Training Area (PSC FT-07E).
- F-15 Burial Site (PSC OT-08).
- Canberra Burial Site (PSC OT-09).
- Concrete Rubble Burial Site (PSC OT-10).
- Former Outside Transformer Storage (PSC SS-11).
- Old Explosive Ordnance Division (EOD) Burial Site (PSC OT-12).
- Drainage Ditch Disposal Area (PSC DP-13).
- Old Salvage Yard Burial Site (PSC LF-14).
- Facility 328 Spill Site (PSC SS-15).
- Facility 321 Underground Storage Tank (UST) (PSC SS-16).
- Former Defense Property Disposal Office (DPDO) Yard (PSC SS-17).
- Base Exchange (BX) Leaking USTs (PSC ST-19).
- Oil/Water Separator Canal and Earth Fissures (PSC SD-20).
- Sewage Treatment Plant Effluent Canal (PSC SD-21).
- Base Ammunition Storage Area (PSC DP-24).
- Northwest Landfill (PSC LF-25).
- Hush House Canal (PSC SD-26).
- Northeast Landfill (PSC LF-37).
- Southwest Oil/Water Separator at the Auto Hobby Shop (SD-38).
- Waste Discharge at the Old Lockheed Site (SD-39).
- Skeet Range (OT-41).
- Bulk Fuels Storage (SS-42).

A more detailed description and background information for OU-1 and OU-2 PSCs is in Appendix A. It is important to note that PSCs 27 through 36 do not exist because there was a break in the numbering between PSC SD-26 and PSC LF-37.

1.2 Purpose

This report summarizes the remedial actions and data collected since the beginning of the project in August 1990 through November 2001 and provides an evaluation of the

effectiveness of the remedial actions relative to remedial objectives and to verify that remedial actions remain protective of human health and the environment.

The need for this five-year review was identified during preparation of the Final Close Out Report (FCOR)¹ as part of the delisting process. This review is required because hazardous substances, pollutants, or contaminants remain in the subsurface at concentrations that are above levels that allow unrestricted land use. As the delisting process progressed, it was determined that the five-year review would be required because of the amount of time that has lapsed since finalization of the OU-2 Record of Decision (ROD) in January 1994.

This five-year review report is intended to be a concise summary of the work that was conducted at OU-1 and OU-2 to meet the statutory requirements of the Superfund process at Luke AFB. Numerous references are provided as part of this report however, not all support documents may be referenced. Rather, the most relevant documents are referenced in support of the objectives of the five-year review.

2.0 Site Chronology

2.1 Operable Unit 2

This section of the five-year review report provides a summary of the chronology of events for the implementation of the remedial alternatives for OU-2 at Luke AFB. The chronology of events for PSCs ST-18 and DP-23 are summarized in Tables 2-1 and 2-2, respectively.

Table 2-1. Chronology of Events for the Construction of the Concrete Cap at PSC ST-18

Date	Event
October 19, 1983	RCRA closure of facility 993 begins.
April 19, 1988	Final inspection of concrete cap construction.
September 27, 1990	Signing of the FFA transferring jurisdiction of ST-18 to CERCLA.

¹ ARCADIS Geraghty & Miller. 2001. Final Close-Out Report, Luke Air Force Base, Arizona. April 5, 2001.

Date	Event
January 28, 1994	Signing of the OU-2 ROD.
Annually	Cap inspection and maintenance at PSC ST-18.
Five year review	Groundwater monitoring.

Table 2-2 Chronology of Events for the Ex-situ Bioremediation (Soil Composting) at PSC DP-23

Date	Event
January 28, 1994	Signing of the OU-2 ROD.
April 11, 1995	Conduct preliminary soil sampling to further characterize the site.
May, 1994	Submittal and agency approval of the remedial design Report.
July 7, 1995	Excavation of contaminated soil and mixing in treatment cell.
October, 1995	Interim sampling to check status of bioremediation.
April 3, 1997	Addition of optimized soil amendment mix and continued soil composting.
June 5, 1997	Final sampling and begin construction demobilization.
August 1, 1997	Site restoration; re-grading and hydro seeding.
August 6, 1997	Conduct final site inspection.
August 27, 1997	Submit final closure report.

2.2 Operable Unit 1

This section of the five-year review report provides a summary of the chronology of events for the implementation of the remedial alternatives for OU-1 at Luke AFB. The chronology of events for the eight OU-1 sites are summarized in Table 2-3. The chronology for the SVE at PSC SS-42 is summarized in Table 2-4.

Table 2-3 Chronology of Events for the OU-1 Remedial Action

Date	Event
September 7, 1999	Final signatures on the OU-1 ROD.
December 16, 1999	Remedial design workplan for PSC LF-25 submitted.
December 17, 1999	Conducted metal shot recovery at PSC LF-25.
December 21, 1999	Radiological monitoring points installed at PSC RW-02.
December 29, 1999	Perimeter fencing installed around containment structure at PSC RW-02.
January 5, 2000	Revisions to base general plan implemented and policy letter established to implement required institutional controls.
January 12, 2000	Radiological LTM plan for PSC RW-02 submitted.
June 15, 2000	VEMURs filed for PSCs RW-02, LF-03, FT-07E, DP-13, LF-14, LF-25, and SD-38 to restrict residential development of the sites.
November 13, 2000	Institutional Control Plan (ICP) developed and submitted.
Annually	Radiological monitoring at RW-02.

Table 2-4 Chronology of Events for the SVE at PSC SS-42

Date	Event
May 1995	Wells installed for bioventing treatability study.
August 6, 1996	Initiation of SVE using Internal Combustion Engine (ICE).
June 1997	Soil Boring CB-1 advanced to determine effectiveness of ICE.
November 2, 1998	Shut down of SVE system.
January 7, 1999	Second boring advanced to determine effectiveness of SVE.
September 7, 1999	OU-1 ROD signed requiring five-year groundwater monitoring.
May 12, 2000	Groundwater LTM plan for PSC SS-42 submitted.
May 16, 2000	First groundwater sampling event of five-year monitoring completed.

Date	Event
May 22, 2000	Soil vapor extraction and confirmation sampling summary report submitted.
Annually	Groundwater monitoring.

3.0 RI/FS Results and ROD Findings

The section of the report summarizes RI/FS results as recorded in the RODs for OU-1² and OU-2³. The purpose of this section of the five year review report is to identify what COCs were evaluated as part of the RIs, which COCs exceeded standards established for the project, and what remedies were selected to address impacts for applicable PSCs.

3.1 OU-2 RI/FS Results

OU-2 included the investigation of soils at eight PSCs at which only petroleum-related wastes were believed to have been disposed. The location of the OU-2 PSCs are in Figure 1-2. The OU-2 RI/FS was conducted in accordance with USEPA guidance⁴ and approved work plans^{5,6,7,8,9}. The OU-2 field activities were limited to soil evaluations.

² Geraghty & Miller, 1999. Final Record of Decision, Operable Unit 1. Luke Air Force Base, Arizona. January 1999.

³ Geraghty & Miller, 1994. Final Record of Decision, Operable Unit 2. Luke Air Force Base, Arizona. January 1994.

⁴ USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final: Office of Solid Waste and Emergency Response, OSWER Directive 9355.3-01.

⁵ Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final Base-Wide Remedial Investigations/Feasibility Study Work Plan, August 1991.

⁶ Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final Base-Wide Sampling and Analysis Plan, August 1991.

⁷ Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final OU-2 Remedial Investigations/Feasibility Field Sampling and Analysis Plan, November 1991.

⁸ Geraghty & Miller, 1992. Final Addenda for the Remedial Investigation/Feasibility Study Planning Documents, May 1992.

⁹ U.S. Army Corps of Engineers, 1991. Scope of Services, Operable Unit #2, Remedial Investigation/Feasibility Study (RI/FS), Luke Air Force Base, Arizona, August 9, 1991.

OU-2 RI results are detailed in the OU-2 RI report¹⁰. Part of the FS, USEPA guidance¹¹ was used to calculate Preliminary Remediation Goals (PRGs) for OU-2 soils. OU-2 FS results are detailed in the OU-2 FS report¹². OU-2 RI/FS results are summarized in Table 3-1.

¹⁰ Geraghty & Miller, 1992. Final Remedial Investigation Report, Operable Unit 2, Luke Air Force Base, Arizona, October 20, 1992.

¹¹ USEPA, 1991. Human Health Evaluation Manual Part B: Development of Risk-Based Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, DC.

¹² Geraghty & Miller, 1993. Final Feasibility Study Report, Operable Unit 2, Luke Air Force Base, Arizona, May 12, 1993.

Table 3-1 Summary of RI/FS Results for OU-2

PSC	Description	COCs evaluated	COCs in excess of Industrial PRGs	Selected Remedial Alternative
OT-04	Old perimeter road POL waste site	Bis (2-ethylhexyl) phthalate, butylbenzylphthalate, TRPH, copper, lead	Less than PRGs	No action
DP-05	POL Waste Disposal Trench	Ethylbenzene, xylenes, bis (2-ethylhexyl) phthalate, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Less than PRGs	No action
FT-06	South fire training area	2-butanone (MEK), ethylbenzene, 2-hexanone (MBK), 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, bis(2-ethylhexyl) phthalate, butylbenzylphthalate, chrysenedibenzo(a,h)anthracene, dibenzofuran, di-n-butylphthalate, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, 2-methylnaphthalene, 4-Methylphenol, Naphthalene, Pentachlorophenol, Phenanthrene, Phenol, Pyrene, TRPH, Metals, Copper, Lead	Trichloroethene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene	Below the risk range
FT-07 W	Western portion of the north fire training area	benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, 2-methylnaphthalene, naphthalene pyrene, TRPH, copper, lead	Less than PRGs	No action

PSC	Description	COCs evaluated	COCs in excess of Industrial PRGs	Selected Remedial Alternative
ST-18	Facility 993	benzene, 1,1 dichloroethene, ethylbenzene, 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, TRPH, copper, lead	Benzene, 1,1,2,2-Tetrachlorethane, Benzo(a)pyrene	Maintain concrete cap, groundwater monitoring during each five-year review
DP-22	POL trench at northeast runway	acetone, TRPH, copper, lead	Less than PRGs	No action
DP-23	Old surface impoundment west of facility 999	ethylbenzene, toluene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, copper, lead	Benzo(a)anthracene Benzo(k)fluoranthene Benzo(a)pyrene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Ex-situ biological treatment
SD-40	Taxiway discharge area	acetone, benzene, ethylbenzene, toluene, xylenes, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Less than PRGs	No action

3.2 OU-1 RI/FS Results

OU-1 included the investigation of soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. In addition to the investigation of identified PSCs, a RCRA facility assessment (RFA) and RCRA facility investigation (RFI) were conducted to determine if any of the current operational facilities at Luke AFB should be included as PSCs in the CERCLA program. The results of the RCRA investigation are in Appendix A of the OU-1 report¹³. The location of PSCs in OU-1 are in Figure 3-2.

Prior to the beginning of the OU-1 RI field activities, the FFA parties determined that “no further remedial investigations” were needed at eight OU-1 PSCs, as follows:

- PSCs OT-01, OT-08, and OT-09 were classified as “no further action” sites because data obtained during an extensive review of Base records showed that hazardous materials or wastes were never handled or disposed at these sites.
- PSC DP-24 was removed from the Superfund process because it had mistakenly been included on the list of potentially contaminated sites.
- PSCs SS-15, SS-16, and ST-19 were removed from the Superfund process and placed under the jurisdiction of the ADEQ Underground Storage Tank (UST) section.
- PSC OT-10 was removed from the list of sites requiring field investigations because that site lies completely within the boundaries of PSC DP-13 and the landfill contents of both sites were presumed similar.

Because of its complexity, the OU-1 RI field investigation was divided into three phases, phase I conducted from October 1991 through March 1992, phase II activities conducted from June 1992 through April 1994 and phase III activities conducted in August and September 1996. Phase III activities were required to collect additional data for risk assessment purposes due to Phase I and Phase II laboratory data quality issues. However, the information reported as part of this five-year review is based on a consolidation of the most defensible data collected in conjunction with the overall Superfund process in terms of quality control and assurance (QA/QC) protocol.

¹³ Geraghty & Miller, 1997 Final Remedial Investigation Report OU-1, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1997.

The OU-1 RI/FS was conducted in accordance with USEPA guidance² and approved work plans^{3,14,15,16,17}. OU-1 RI investigation results are detailed in the OU-1 RI report¹³.

As part of the OU-1 FS, a risk-based assessment was performed regarding acceptability of PSCs for residential land use given current conditions. Residential land use implies that a site can be developed and used for any purpose, including residential development. If a PSC was deemed unsuitable for residential land use, remedial alternatives were developed for that site. Remedial alternatives were also developed for any site that could potentially impact underlying groundwater resources in the future. The OU-1 FS results are detailed in the OU-1 FS report¹⁸. OU-1 RI/FS results are summarized in Table 3-2.

¹⁴ Geraghty & Miller, 1993c. OU-1 Phase II Remedial Investigation/Feasibility Study Field Sampling and Analysis Plan, Luke Air Force Base, Arizona.

¹⁵ Geraghty & Miller, 1994. Bioventing Treatability Study Sampling and Analysis Plan for PSC SS-42. Luke Air Force Base, Arizona.

¹⁶ Geraghty & Miller, 1995. Final Sampling and Analysis Plan Environmental Evaluation in Support of the Ecological Risk Assessment, Luke Air Force Base, Arizona.

¹⁷ Geraghty & Miller, 1995. Final Sampling and Analysis for the Additional Sampling Investigations in Support of the Luke AFB CERCLA investigation, Luke AFB, Arizona.

¹⁸ Geraghty & Miller, 1998. Final OU-1 Feasibility Study Report, Luke Air Force Base, Arizona. March 1998.

Table 3-2 Summary of OU-1 RI/FS Results

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
OT-01	Old incinerator site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action
RW-02	Wastewater treatment annex landfill	2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butyl phthalate, di-n-octyl phthalate, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, uranium, zinc, gross alpha, gross beta, radium-226, radium-228	Radionuclides are currently be monitored, however the COCs were below risk standards	Institutional controls, radiological monitoring and fencing
LF-03	Outboard runway landfill	TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	COCs below risk standard	Institutional controls
FT-07E	Eastern portion of north fire training area	acetone, ethylbenzene, toluene, xylenes, TRPH, arsenic, barium chromium, copper, lead, nickel, zinc	TRPH are below non-residential ADEQ SRLs	Institutional controls
OT-08	F-15 burial site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action
OT-09	Canberra burial site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
OT-10	Concrete rubble burial site	This site lies completely within the boundaries of DP-13.	RI not required	No action
SS-11	Former outside transformer storage	PCBs	Risk below risk range	No action
OT-12	Old explosive ordnance division (EOD) burial site	Acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, carbazole, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, pentachlorophenol, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc, cyanide	Risk below risk range, with the exception of Benzo(a)pyrene	No action
DP-13	Drainage ditch disposal area	acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, zinc, cyanide	Chromium Lead Benzo(a)pyrene	Institutional controls
LF-14	Old salvage yard burial site	Xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, butyl benzyl phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, PCBs, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc, cyanide,	Polychlorinated Biphenyls (PCB)	Institutional controls

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
SS-15	Facility 328 spill site	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ jurisdiction
SS-16	Facility 321 underground storage tank (UST).	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ jurisdiction
SS-17	Former defense property disposal office (DPDO) yard.	chrysene, di-n-octyl phthalate, fluoranthene, pyrene, PCBs, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range	No action
ST-19	Base exchange (BX) leaking USTs.	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ UST jurisdiction
SD-20	Oil/water separator canal and earth fissures.	Toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
SD-21	Sewage treatment plant effluent canal	Anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
DP-24	Base ammunition storage area	Removed from the Superfund process because this site was mistakenly included on the list of potentially contaminated sites.	RI not required	No action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
LF-25	Northwest landfill	Xylenes, benzo(a)anthracene, benzo(a)prene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc, cyanide	Lead and antimony were above risk range	Lead shot recovery Institutional controls
SD-26	Hush house canal	ethylbenzene, toluene, xylenes, 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butylphthalate, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range	No action
LF-37	Northeast landfill	benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chrysene, fluoranthene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium [b] copper, lead, nickel, silver, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
SD-38	Southwest oil/water separator at the auto hobby shop	TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc	TRPHs were below non-residential ADEQ SRLs	Institutional controls
SD-39	Waste discharge at the old Lockheed site	diethyl phthalate, TRPH, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc	Risk below risk range	No action
OT-41	Skeet range	Lead	Risk below risk range	No Action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
SS-42	Bulk fuels storage	Benzo(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butylphalate, fluoranthene, pyrene, TPH, lead	Benzene, Toluene, Total Xylenes, TPH	Soil vapor extraction (SVE) and five-year groundwater monitoring

3.3 OU-2 ROD Summary

The description of the remedy in the OU-2 ROD is summarized in Table 3-3.

Table 3-3 Description of the Remedy for OU-2

PSC	Selected Remedy	Implemented Remedial Components
ST-18	Capping, Surface Controls, and Groundwater Monitoring.	Concrete CAP installed in 1987, Annual Inspection and maintenance of a concrete cap and groundwater monitoring during each 5-year review
DP-23	Excavation, ex-situ biological treatment, confirmation sampling, and on-site disposal of impacted soils from the canal portion.	Design and implementation of excavation and on-site ex-situ biological treatment of soils impacted by PAHs above industrial PRGs.

3.4 OU-1 ROD Summary

The description of the remedy in the OU-1 ROD is summarized in Table 3-4.

Table 3-4 Description of the Remedy for OU-1

PSC	Selected Remedy	Implemented Remedial Components
RW-02	Institutional Controls, Radiological Monitoring, and Fencing	<ul style="list-style-type: none"> • Voluntary Environmental Mitigation Use Restriction (VEMUR) executed and recorded to restrict land use to non-residential purposes. • Base General Plan (BGP) modified to place constraints on future residential development of the site. • Geophysical monitoring program to ensure safety of potential receptors and warning mechanism in case subsurface conditions change. • Perimeter fencing. • Institutional Control Plan (ICP) to maintain and document required institutional controls.
LF-03	Institutional Controls	<ul style="list-style-type: none"> • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.
FT-07E	Institutional Controls	<ul style="list-style-type: none"> • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.

PSC	Selected Remedy	Implemented Remedial Components
DP-13	Institutional Controls	<ul style="list-style-type: none"> • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site. • An ICP to document required institutional controls.
LF-14	Institutional Controls	<ul style="list-style-type: none"> • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.
LF-25	Institutional controls/ ex-situ physical treatment/metal recovery	<ul style="list-style-type: none"> • The area of impacted soils containing COCs in excess of evaluated criteria to be further delineated. • Surficial soils with COCs in excess of Arizona soil remediation standards to be excavated and disposed. • Remediation of metal shot via mechanical sifting and gravimetric separation. • Recovered metal shot recycled or disposed. • Soil material returned to excavated areas. • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • Work practices requiring the use of PPE while excavating the site. • An ICP to document required institutional controls.
SD-38	Institutional Controls	<ul style="list-style-type: none"> • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional
SS-42	Soil Vapor Extraction and Groundwater Monitoring	<ul style="list-style-type: none"> • Install SVE System. • Monitor soil and groundwater to confirm effectiveness of remedy.

4.0 Summary of Base-wide Risk Assessment

This section of the report provides a summary of the approach used in the development of the Base-wide risk assessment¹⁹. The risk assessment evaluated current and potential future risks to human health and the environment from exposure to the constituents of potential concern (COPCs) in soil, sediment, groundwater, surface water, and ambient air at each of the PSCs. The following summarizes the results of

¹⁹ Geraghty & Miller, 1997. Final Remedial Investigation Report OU-1, Appendix B – Baseline Base Wide Risk Assessment, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1997.

the risk assessment. Luke AFB is an active military facility, and is expected to remain active in the foreseeable future. Therefore, the most likely type of exposure is for industrial workers rather than residents. Exposure to soil and sediments included the ingestion, dermal contact, and inhalation of fugitive dusts and/or vapors. Risks from exposure to soils and sediments were evaluated using either surficial, base worker scenario (0 to 2 feet bgs) or combined surface and subsurface, excavation worker (0 to 16 feet bgs) data. Exposure to groundwater was evaluated through the ingestion and dermal contact pathways. Potential groundwater exposure was evaluated using production well sampling data as well as data collected from groundwater monitoring wells.

Potentially exposed populations considered in the risk assessment included the following:

- Base workers
- Excavation workers
- Military personnel
- Child visitors for sites which extend off the base property
- Base residents.

The risk assessment considered both average and reasonable maximum exposure conditions to characterize current and future risks. During the five-year review, exposure point concentrations (EPC) were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution. For PSCs with post-remediation data, the EPC was taken from the maximum concentration from the appropriate soil horizon or medium.

The USEPA established risk-based guidance goals as an aid in determining which sites would be acceptable for use in an industrial setting in the absence of remediation. Sites at which a non-cancer hazard index (HI) greater than or equal to 1.0 or an excess lifetime cancer risk (ELCR) greater than the risk of 1×10^{-6} to 1×10^{-4} , as determined by risk assessment, generally would require remediation and would therefore be recommended for inclusion in the FS.

Arsenic and beryllium were found to be constituents that potentially contributed most significantly to the estimates of risk in the assessment. The results of the risk assessment were reevaluated to determine the impact background had on the level of risk at the various PSCs. When background was considered in the evaluation, it was found that most of the naturally occurring inorganic constituents (e.g., arsenic,

beryllium) were present at background levels. Remediation to concentrations below background is not typically required by USEPA. Therefore, based on this reevaluation of the risk assessment results, only two PSCs, LF-25 and SS-42, were found to pose a risk above the target risk range.

To determine whether the PSC areas at Luke AFB are suitable for future residential land use, risks from exposure to soil by a hypothetical future resident were evaluated. Because Luke AFB is an active military facility, and is expected to remain active in the foreseeable future, calculating risks for residential exposure to soils at each of the PSCs is highly conservative; it is unlikely that the active portions of Luke AFB will be used for residential purposes in the future. The ADEQ proposed soil remediation levels (SRLs)²⁰ and the USEPA Region IX PRGs were used in the residential exposure evaluation.

Risks from residential exposure to combined surface and subsurface soil were calculated using both the USEPA Region IX PRGs and the ADEQ SRLs. Based on the results of the evaluation, all of the PSC areas evaluated were determined to be suitable for unrestricted, or residential land use with the exception of the following PSCs:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- ST-18
- LF-25
- DP-23 N
- SD-38

In addition to evaluating potential human exposure at Luke AFB, an ecological risk assessment was also performed. Prior to completing the ecological risk assessment, a Base-wide ecological inventory (EI) was conducted to collect data on:

- Biotic communities present on the base.
- Evidence of biological stress.
- Pathways of potential exposure to impacted media.

²⁰ ADEQ, 1996. A.A.C. Title 18, Chapter 7, Article 2, Appendix A. Soil Remediation levels.

- The presence of species of special concern.

Luke AFB is in the lower Colorado River Valley of the Sonoran Desert. However, little vegetation characteristics of this area were identified during the EI. Instead, flora was dominated by vegetation characteristic of urban, disturbed areas at similar elevations in the Sonoran Desert. This is consistent with current and past land use at the Base.

No species of special concern were observed during the EI. Animal species observed at the Base during the EI are more tolerant of urban and disturbed conditions. Because vegetative growth at the Base is sparse due to physical activities associated with normal operations, the diversity and abundance of animals observed were less than that typical in more native conditions.

Potential risks to ecological receptors were assessed quantitatively by using the round-tailed ground squirrel, desert cottontail, western whiptail lizard and side-blotched lizard as indicator species. The desert cottontail was used to represent herbivorous primary consumers; the round-tailed ground squirrel to represent herbivorous/insectivorous primary consumers; and the western whiptail lizard and side-blotched lizard to represent insectivorous secondary consumers. HQs were calculated for the indicator species by comparing an estimated intake of site-related constituents of ecological concern (COECs) with a toxicity reference value derived for the specific indicator species and for the specific COEC. Hazard quotients (HQs) were determined for the ingestion of food sources and for the incidental ingestion of soil where appropriate for the indicator species. The HQs were then added to obtain a HI for each PSC.

Based on previous investigations at Luke AFB and coordination with USEPA representatives, the following PSCs were determined to be representative of site conditions and were selected for study in the ecological risk assessment:

- LF-25
- FT-07
- Combined portions of SS-17 and LF-14
- SD-20

This selection was based on a combination of observations of ecosystems at the PSCs, detected COEC concentrations, and potential risks to higher trophic level organisms.

COECs evaluated in the ecological risk assessment included the following:

- PAHs
- TPH
- PCBs
- Antimony
- Cadmium
- Lead

Data used to assess potential adverse effects to ecological receptors included chemical analysis of soil, plant tissue, and insect tissue. Based on the results of the ecological assessment, it is unlikely that site-related COEC concentrations would pose a risk to ecological receptors at Luke AFB.

5.0 Groundwater Summary

This section of the five-year review report provides information on the hydrogeology of Luke AFB and surrounding region. Also provided is information on the status of monitor wells and a summary of groundwater monitoring results for PSCs.

5.1 Groundwater Hydrology

5.1.1 Aquifer Units

The occurrence and movement of groundwater at Luke AFB is affected by hydraulic characteristics of the aquifer units, and the magnitude and distribution of groundwater recharge and discharge for agriculture and other uses. Aquifer units include the upper alluvial unit (UAU), middle fine unit (MFU) and lower conglomerate unit (LCU). Withdrawals in excess of recharge have created declines in water levels in the Luke AFB area of 300-feet²¹. Structural changes associated with the Luke Salt Body significantly affect local groundwater conditions south and east of the Luke AFB.

Interpolation of data from the regional study of Brown and Pool²² indicates that the UAU has been completely dewatered in the Luke AFB area, except for localized

²¹ US Geological Survey, 1994. Hydrogeological Characterization and Land Subsidence Investigation for Luke Air Force Base, Arizona.

²² US Geological Survey, 1998. Water Resources Investigation Report 88-4202, 1989, Hydrogeology of the Western Part of the Salt River Valley, Maricopa County, Arizona (Brown, JamesG. Pool, D.R.)

areas along the Agua Fria River, near the Luke AFB Waste Water Treatment Plant (WWTP). Partial dewatering of the MFU has also occurred in the Luke AFB area. The upper most aquifer is now the MFU.

5.1.2 Regional Recharge

Groundwater recharge in the WSRV is affected by natural as well as artificial sources. Groundwater is naturally recharged by infiltration through the beds of river channels during stormwater events or releases from upstream impoundments. Water levels in Monitoring Well MW-101, situated near the Aqua Fria River, rose approximately 25-feet between December 28, 1992, and March 14, 1993, in response to upstream releases from Lake Pleasant Reservoir²³.

Artificial sources of groundwater recharge include infiltration of excess irrigation water applied to fields and seepage losses from irrigation ditches and canals. Infiltration of treated effluent from the Luke AFB WWTP may also provide recharge in the immediate area of the releases to the Aqua Fria River floodplain. Potential recharge due to other activities at the Luke AFB is discussed in greater detail in the Vadose Zone leaching model presented in the Base-wide risk assessment.

5.1.3 Regional Discharge

Groundwater discharge from the regional aquifer in the Luke AFB area occurs primarily from cultural uses. Owing to the depth to the water table, there is no natural discharge due to evapotranspiration or discharge to surface water bodies. Discharge of groundwater occurs principally from pumpage from numerous wells, primarily for irrigation with the remainder for municipal, military, and light industrial consumption.

The amount of groundwater discharge for municipal usage is anticipated to increase dramatically in response to the growing population of the area (Water Resources Associates, 1994). As the population increases in the area it is anticipated that groundwater discharged for agricultural uses will decrease (Water Resources Associates, 1994). Comparison of the increased withdrawals for municipal uses and decreased withdrawals for irrigation uses shows that the demand for groundwater in the area will remain generally the same into the foreseeable future. However, the

²³ Geraghty & Miller, Inc. 1993d. OU-1, Phase II, Remedial Investigations/Feasibility Study Planning Documents for PSC SS-42, Luke Air Force Base, Arizona.

transition from irrigation uses to municipal uses will put greater importance on water quality.

5.1.4 Historical Trends in Regional Groundwater Levels

Groundwater levels declined more than 300 feet in the vicinity of Luke AFB over a 40+ year period from 1923 to the late 1970s, primarily because of significant overdraft in response to pumpage for irrigation requirements. The greatest declines occurred west, north, and south of Luke AFB. A large cone of depression has existed southwest of the Luke AFB prior to 1964. The regional groundwater flow direction is to the south-southwest modified by the cone of depression.

Water levels from selected wells for which data were adequate were plotted to show groundwater declines over time at a given location. Analysis of these hydrographs suggests that water levels have declined substantially over most of the study area through at least 1980. After 1980, many of the hydrographs show a leveling off of the decline trend, or a groundwater rise of up to 40 to 60 feet. Groundwater table altitudes in the study area have continued to rise due to reduction in pumpage and increased recharge related to above average precipitation over the early 1980s in the Phoenix area. The availability of Colorado River water via the Central Arizona Project (CAP) canal (especially for agricultural irrigation) has greatly lessened the demands placed on groundwater in the Phoenix area, and has resulted in the groundwater table rising throughout much of the area.

Water level data for the period 1991 to 1995, documents a continued rise in the groundwater table throughout the study area. Altitudes had increased up to 20 feet, in large part due to above average precipitation for 1992 and 1993. Overall, the historical groundwater altitude data for the study area shows a consistent pattern of water level decline over time despite the limitations in the data previously described.

5.1.5 Groundwater Occurrence, Apparent Gradient, and Estimated Flow Directions in the Luke AFB Area

Water Level Measurements

The water level measurement program was established for the Luke AFB RI and included monthly water level measurements and continuous water level measurements. Monthly water level data were collected to evaluate seasonal water level responses from regional stresses on the groundwater system. Continuous water level measurements were collected at selected monitoring wells using pressure transducers

and data loggers. Continuous water level data were collected to evaluate local water responses from regional as well as local pumping stresses due to both off base and on-Base production well pumping²⁴. Because several different production wells are in use, the data loggers and transducers were periodically moved to collect data from all parts of the Base.

The monthly water level program included measurements of all monitoring wells and selected off Base wells. The program began in October 1990, and extended through December 1995.

Continuous water level recorders were installed periodically in Monitoring Wells MW-3, MW-5, MW-102, MW-103, MW-104, MW-106 through MW-111, MW-112S, MW-112D, MW-113, MW-117, MW-118, MW-119, MW-121, MW-123 and Inactive Production Well IP-PW-12. Nearby on Base production wells, which potentially affected water levels, include Production Wells PW-4, PW-7, PW-9, PW-10, PW-11, PW-12, PW-13, and PW-14.

Well Perforated Intervals and Measured Water Levels.

All of the monitoring wells at the main part of Luke AFB are screened entirely within the MFU. Interpolation of data from the regional study indicates that all monitor well locations near the Luke AFB WWTP (MW-101, MW-115, MW-116, and MW-124) are screened in the UAU. Monitoring Well MW-101 is primarily screened in the UAU with the lower portion of the screen extending into the MFU. Monitoring Wells MW-115, MW-116, and MW-124 are screened in the lower portions of the UAU. All of the monitoring wells at the main Base, except for Monitoring Wells MW-102, MW-103, and MW-112D are screened in upper parts of the saturated thickness of the MFU.

The Luke AFB production wells are screened typically in the LCU with some wells also screened in the MFU. Seven of the 15 off Base wells included in the monthly water level network are exclusively perforated within the MFU, and five other off Base wells are perforated within both the MFU and LCU. Six of the off Base wells may have casing collapses below the current indicated depth of the well, which may suggest that these wells may be open to the formations below the indicated depth of

²⁴ Geraghty & Miller, Inc., 1992. First Quarter 1992 Quarterly Well Measurement Report, Hydrogeological Survey, Luke Air Force Base, Arizona.

perforations. Limited hydraulic connection may exist in the well bore with deeper portions of the formation at the location of the casing collapse.

Limitations in the Construction of Water Level Altitude Contour Plots

Water level altitude contour plots are typically used to infer groundwater flow directions. Evidence from water levels measured at site-specific PSC wells at Luke AFB suggest that semi-independent groundwater zones have developed at the local scale as the result of long-term water level declines in response to regional groundwater withdrawals in excess of recharge. Water level measurements also suggest that head differences between zones have created vertical gradients within and between these zones. The development of these semi-independent groundwater zones makes it imperative that water level measurements used in the construction of water level altitude contours be from wells with perforated intervals which extend and penetrate into similar lithologic portions of these zones or when compatible data is not available, that the data be used with an understanding of its comparability and hence the accuracy of the resulting plot. One approach is to use contour intervals that are large enough to limit the effect of small vertical head gradients within these zones.

Evidence which supports the existence of semi-independent groundwater zones at Luke AFB includes anomalous water levels within similar areas, limited or non-response of water levels in wells near pumping wells, and limited or non-response of water levels in wells to seasonal water-level changes experienced by other nearby wells. Anomalous water levels occur at PSC SD-20 where water levels are as much as 50-feet lower than at PSCs immediately to the northwest. These anomalous water levels are suspected to be attributed to the geologic structure associated with the Luke Salt Body.

Non-responsive water levels in wells near a pumping well occur at PSC FT-07 where pumpage from production well PW-12 (approximately 1,000 gallons per minute) does not cause any direct water level response in nearby monitoring wells. The lack of response of the water levels is suspected to be attributed to an aquitard which most likely occurs between the largest penetrating perforated interval of the monitoring wells at the PSC (453 feet bgs at MW-109) and the top of the perforated interval of the production well (600 feet bgs at PW-12). This aquitard limits the vertical hydraulic connection between the perforated intervals of these wells.

Water level changes at PSC FT-07 also experience the smallest amplitude of seasonal change of any of the monitoring wells at Luke AFB. Seasonal water level amplitudes in the monitoring wells at PSC FT-07 average approximately five feet. Seasonal water level amplitudes in monitoring wells at other Luke AFB PSCs range from

approximately five feet at PSCs FT-06/ST-18 to 23 feet at PSC SD-20. The limited response of water levels in these wells to regional changes in water levels is likely caused by the aquitard, which is suspected to exist at this location.

Evidence which supports the existence of vertical head gradients within groundwater zones include water level differences between nearby wells with slight to significant differences in saturated extent and penetration of perforated intervals. This is evident at PSC FT-07 and SD-20. Monitoring wells MW-110 (saturated perforated interval from approximately 362 to 398 feet bgs [screened interval from approximately 362 to 398 feet bgs]) and MW-123 (saturated perforated interval from approximately 340 to 395 feet bgs [total screened interval from 295 to 395 feet bgs]) at PSC FT-07 located within 30 feet of each other have consistent differences in water levels of approximately three feet. Measurements at monitoring wells MW-112S (saturated perforated from approximately 290 to 342 feet bgs [screened interval from 780 to 722 feet above mean sea level]) and MW-112D (saturated perforated interval from 381 to 428 feet bgs [screened interval from 682 to 632 feet above mean sea level]) at PSC SD-20 have indicated differences in water levels of 0.5 to 8.5 feet (Figure 4-48).

The hydraulic effects associated with the development of the semi-independent groundwater zones at Luke AFB requires special precautions in the construction of site-specific PSC water level altitude contour plots. Water level data used to construct water level contours needs to be relatively comparable in that data should be from wells, which measure similar lithologic portions of the water zones. However, most PSCs have limited number of wells, which measure similar lithologic portions of the water zones. Water-level altitude contour plots for the site specific PSCs have therefore been constructed with the use of site-specific and regional water level measurements, and a contour interval of ten feet to limit the impact of the effects. Regardless of these precautions, groundwater flow directions inferred from these contour plots should still be viewed with a degree of scrutiny, and should only be used as the direction of a general groundwater flow at the time of water level measurement.

Contour intervals at site specific PSCs at Luke AFB were constructed using a regional ten feet contour interval. Because of the inherent effects on measured water levels from the vertical component of flow, the regional contours provide the best representation of the lateral groundwater flow direction a two dimensional contour plot can achieve.

Impact of Luke Salt Body on Groundwater Flow

The Luke Salt Body has impacted groundwater movement in the study area. Groundwater flow in the vicinity of the salt mass has been affected in several ways. Doming of the Luke Salt Body has deformed the overlying and peripheral sediments through high angle faulting and folding, as mentioned previously in Section 4.6.5. Furthermore, permeability and anisotropy of the basin fill sediments in the study area have been altered by depositional changes from proximal coarse-grained to distal fine-grained sediments peripheral to the Luke Salt Body, and compaction of the fine-grained sediments overlying the Luke Salt Body. In conjunction with the structural complexities, the result has been to create a complex groundwater flow regime in the vicinity of the Luke Salt Body. The effect on groundwater movement and aquifer properties along the southern portions of the Base is not fully understood.

Regionally, the localization of fine-grained sediments and the additional compaction over the Luke Salt Body have resulted in reduced transmissivities east and south of Luke AFB within the basin fill units^{25,26}. This reduction has impacted regional groundwater movement into the pumping areas west of Luke AFB, with higher water levels to the east of the Base (near WWTP) and lower water levels in wells in the western part of Luke AFB. Although the groundwater flow across the site is generally southwest, near monitoring wells MW-112 and MW-113, the groundwater flow is northwest because of the Luke Salt Body.

5.2 PSC Groundwater Summary

The status of groundwater monitoring wells at Luke AFB is summarized in Table 5-1. The location and status of groundwater monitoring wells is in Figure 5-1. Groundwater sampling results are summarized in Table 5-2 and Figure 5-2. In addition, a table that provides groundwater monitoring results including sampling dates and concentrations of COCs for all wells for the period of record is in Appendix B. In general, a review of the data in Appendix B indicate that groundwater at Luke AFB is not impacted as there

²⁵ Stulik, R.S. and F.R. Twenter, 1964. Geology and Groundwater of the Luke Area, Maricopa County, Arizona. USGS Water Supply Paper #1799P.

²⁶ Eaton, G.P., D.L. Peterson, and D.L. Schumann, 1972. Geophysical, Geohydrological, and Geochemical Reconnaissance of the Luke Salt Body in Central Arizona, USGS Professional Paper #753.

are no constituents in groundwater that currently exceed applicable water quality standards and it appears all potential sources of constituents have been controlled or eliminated through the institution of pollution prevention measures or remedial activities. However, there have been some occurrences of COCs above detection limits during the period of record. Therefore, some monitoring will be conducted as part of future five-year reviews to verify that remedies are protective of groundwater. MW-124 (RW-02), MW-118 and MW-123 (FT-07),), MW112S, MW-112D and MW-113 (SD-20) and MW-121 and MW-125 (SS-42) will be monitored for VOCs as part of future five-year reviews. MW-114 and MW-122 (ST-18) will be monitored annually for VOCs and the results evaluated as part of the next five-year review.

The following sections provide a more detailed description of groundwater conditions associated with specific PSCs.

Table 5-1 Status of Groundwater Monitoring Wells

Well ID	Site ID	Site Location	Status	Comments
MW-1	ST-18	Facility 993	Abandoned	Unknown location
MW-2	ST-18	Facility 993	Abandoned	COC concentrations did not warrant additional monitoring.
MW-3	ST-18	Facility 993		Possible RCRA point of compliance
MW-4	ST-18	Facility 993	Abandoned	COC concentrations did not warrant additional monitoring.
MW-5	ST-18	Facility 993		Possible RCRA point of compliance
MW-101	SD-21	Aqua Fria River	ACTIVE	Needed for Compliance Sampling
MW-102	SD-20	Head of O/W Separator Canal	Abandoned	COC concentrations did not warrant additional monitoring.
MW-103	SD-20	Near Ammo. Storage	Abandoned	COC concentrations did not warrant additional monitoring.
MW-104	DP-05	Eastern edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-105	DP-05	Southern edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-106	DP-05	Western edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-107	FT-06	Near Bldg. 1031	Abandoned	COC concentrations did not warrant additional monitoring.
MW-108	FT-06	North of DP-23	Active	

Well ID	Site ID	Site Location	Status	Comments
MW-109	FT-07	Western edge of Site	Active	
MW-110	FT-07	Central portion of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-111	FT-07	North of perimeter road.	Abandoned	COC concentrations did not warrant additional monitoring.
MW-112S	SD-20	Earth Fissures area	Active	
MW-112D	SD-20	Earth Fissures area	Active	
MW-113	SD-20	Earth Fissures area	Active	
MW-114	ST-18	Point of release at ST-18		Possible RCRA point of compliance
MW-115	RW-02	Church parking lot	Abandoned	COC concentrations did not warrant additional monitoring.
MW-116	RW-02	Tanner property		To be Abandoned
MW-117	SD-38	South of Auto Hobby Shop	Active	
MW-118	FT-07	Between FTPs	Active	
MW-119	SS-42	Near central portion of site.	DETERIORATED	To be Abandoned
MW-120	SS-42	CE yard	DETERIORATED	To be Abandoned
MW-121	SS-42	Point of release at SS-42	ACTIVE	Needed for Sampling per OU-1 ROD
MW-122	ST-18	Downgradient of ST-18		Possible RCRA point of compliance

Well ID	Site ID	Site Location	Status	Comments
MW-123	FT-07	Downgradient of FTPs	Active	
MW-124	RW-02	DRMO yard	Active	
MW-125	SS-42	Downgradient of SS-42	ACTIVE- Replaced	Needed for Sampling per OU-1 ROD

Table 5-2 Groundwater Sampling Summary

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-1	RW-02	Benzo(a)pyrene, arsenic, beryllium, cadmium, copper	bis(2-ethylhexyl)phthalate (BEP), arsenic, barium, chromium, copper, nickel, lead, zinc	BEP - Laboratory contaminant chromium, copper, nickel and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-2	DP-05	ethylbenzene, xylenes, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Acetone, toluene, BEP barium, lead, silver, arsenic, barium, chromium, copper, lead, zinc	Acetone and toluene were detected in one well during one sampling event and not detected again. BEP is a common laboratory contaminant. Barium and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	FT-07	arsenic, TRPH	Chloroform, 1,2-dichloropropane (DCP), 1,2-dichloroethane (DCA), toluene, BEP barium, chromium, copper, lead, zinc	Chloroform, DCP, DCA, and BEP were found to laboratory contaminants. Toluene source unknown but detected in only one well. Barium, chromium, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-2	ST-18	benzene, 1,1 dichloroethene, ethylbenzene, 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, benzo(a)anthracene , benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, TRPHs, copper, lead	Toluene BEP, DBCP, 2-butanone, arsenic, barium, chromium, copper, lead, nickel, selenium, zinc and TCE.	Toluene was detected in one well during one sampling event and not detected again. BEP is a common laboratory contaminant and DBCP is an agricultural contaminant. Arsenic, barium, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	Potentially attributable to PSC (monitoring continuing).
OU-1	SD-20	toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, Copper, lead, nickel, zinc	TCE, PCE, DCA, DCP, BEP, acetone, bromodichloromethane, bromoform, chloroform, methylene chloride, arsenic, barium, boron, chromium, copper, lead, nickel, selenium, and zinc	TCE and DCA source unknown but not detected in wells at source area. DCP detected one time. BEP is a common laboratory contaminant. Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	It is possible that TCE originating from points on-base that discharged to the oil water separator canal may have migrated to the groundwater. The fissures at the end of the canal may have provided a pathway for these constituents to reach groundwater.

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-1	SD-21	anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Acetone, carbon disulfide, and BEP arsenic, barium, boron, copper, lead, and zinc	Acetone, carbon disulfide and BEP were found to be laboratory contaminant. Arsenic, barium, boron, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	SD-38	arsenic, beryllium	Barium, copper, lead, and zinc.	Barium, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	SS-42	Benzene, ethylbenzene, toluene, xylene	PCE, DCP, TRPH, TPH, BTEX, arsenic, barium, boron, chromium, copper, lead, nickel, selenium, and zinc.(non-detect for past two years).	DCP is a common laboratory contaminant. TRPH, TPH, and BTEX have been detected inconsistently at the site. The latest sampling results did not contain hydrocarbons. Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	TPH and BTEX were attributal to PSC. Remediation system has been effective in reducing constituents to residual concentrations that will not impact groundwater. Five year monitoring implemented.

5.2.1 PSC RW-02

PSC RW-02 is located approximately 2 miles east of Luke AFB at the WWTP. Three monitoring wells, MW-115, MW-116, and MW-124, were installed at this site. Monitoring wells MW-115 and MW-116 were installed in 1992, and monitoring well MW-124 was installed in 1994. The screened interval has not been submerged during any of the sampling events. Monitoring well MW-115 was abandoned in February 1996. Monitoring wells MW-116 and MW-124 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west.

Concentrations of naturally occurring constituents were compared with site-specific background concentrations as well as with regional background (within Maricopa County). These two comparisons were performed to ensure that the background was well characterized. Arsenic, chromium, copper, nickel, and lead were detected within the range of naturally occurring concentrations. BEP was detected in three samples during the May 1994 sampling event, however, the results were qualified as non-detect because BEP was also detected in the method blank. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, eight validated samples collected from August 1995 to 1998 were non-detect.

The most recent sampling event at the site was in May 1998. A sample was collected from monitoring well MW-124. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring well MW-116 since June 1996 and from MW-115 since February 1996. MW-115 is abandoned. No analytes were detected above laboratory detection limits during these sampling events. MW-124 will be monitored as part of the next five-year review period.

5.2.2 PSC DP-05

PSC DP-05 is located on the southwestern portion of Luke AFB, near Taxiway I. Three monitoring wells, MW-104, MW-105, and MW-106, were installed at this site in 1986. The screened intervals on these wells have been submerged since or right after installation. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described

above. Toluene and acetone were detected in one sample from monitoring well MW-104 and BEP was detected in one sample from monitoring well MW-106 during the third quarter 1992 sampling event. These contaminants were not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, validated samples for five sample events conducted from October 1995 to May 1998 were non-detect.

The most recent sampling event at the site was in May 1998, when a sample was collected from monitoring well MW-105. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring wells MW-104 and MW-106 since June 1996. No analytes were detected above laboratory detection limits during this sampling event. All three wells have been abandoned.

5.2.3 PSC FT-06

PSC FT-06 is located on the southern portion of Luke AFB. Two monitoring wells, MW-107 and MW-108, were installed at this site in 1986. The screened intervals on these wells have been submerged since installation. Both wells are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west-southwest.

Chromium, selenium, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. DBCP, an agricultural contaminant, was detected in samples collected during the fourth quarter 1992 sampling event in concentrations, below the 2000 PRGs, ranging from 0.02 mg/L through 0.05 mg/L. The 2000 PRGs for DBCP are 0.45 mg/L for residential land use and 4.0 mg/L for industrial land use. This was the only sampling event in which DBCP was analyzed. These detections have been attributed to agricultural fields located up-gradient of the site. The most recent sampling events at the site were conducted in 1996. Samples were collected from monitoring wells MW-107 and MW-108. No analytes were detected above laboratory detection limits. MW-107 has been abandoned. MW-108 is scheduled to be abandoned.

5.2.4 PSC FT-07

PSC FT-07 is located on the northern portion of Luke AFB. Five monitoring wells, MW-109, MW-110, MW-111, MW-118, and MW-123, were installed at this site. Monitoring wells MW-109, MW-110, and MW-111 were installed in 1986, monitoring well MW-118 was installed in 1993, and monitoring well MW-123 was installed in 1994. The screened intervals in monitoring wells MW-109, MW-110, and MW-111 have been submerged since installation. Monitoring wells MW-110 and MW-111 were abandoned in 1996. Monitoring wells MW-109, MW-118, and MW-123 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium, chromium, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. Chloroform was detected consistently in monitoring wells MW-110 and MW-123 through the first quarter of 1995. It was again detected in monitoring well MW-123 in 1997 and 1998. The concentrations were well below the MCL and AWQS. Toluene was detected in monitoring well MW-110 during the fourth quarter 1993 and first quarter 1993 sampling events. Toluene was not reported at detectable concentrations in any other sampling events. DCA and DBCP were detected in samples collected during the third quarter of 1992. These analytes were not reported at detectable concentrations in any other sampling events. BEP was detected in the duplicate sample collected from monitoring well MW-110 and the primary sample from MW-111 during the June 1993 sampling event. The presence of BEP appears to be anomalous because the primary/duplicate pair did not contain BEP. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from 14 sampling events conducted from August 1995 through May 1999 were non-detect for all but three events. DBCP, an agricultural contaminant, was detected in samples collected during the fourth quarter 1992 sampling event. This was the only sampling event in which DBCP was analyzed. These detections have been attributed to agricultural fields located up-gradient of the site. Samples from three sample events conducted from October 1995 through June 1996 were non-detect.

The most recent sampling event at the site was in May 1999. A sample was collected from monitoring well MW-123. No analytes were detected above laboratory detection limits. Methylene chloride was detected during the November 1998 sampling event but was qualified because it was also detected in the blank. Monitoring well MW-118

was sampled in May 1998. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring wells MW-109, MW-110, and MW-111 since 1996. No analytes were detected above laboratory detection limits during this sampling event. MW-118 and MW-123 will be monitored as part of the next five-year review period.

5.2.5 PSC ST-18

PSC ST-18 is located on the southern portion of Luke AFB. Six monitoring wells, MW-2, MW-3, MW-4, MW-5, MW-114, and MW-122, were installed at this site. Monitoring wells MW-2 and MW-3 were installed in 1985. Monitoring wells MW-4 and MW-5 were installed in 1987. Monitoring well MW-114 was installed in 1991, and monitoring well MW-122 was installed in 1994. The screened intervals in monitoring wells MW-2, MW-3, MW-4, and MW-5 have been submerged since or just after installation. The screened intervals in MW-114 and MW-122 have not been submerged. Monitoring well MW-2 was abandoned in October 1993. Monitoring well MW-4 was abandoned in October 1994. Monitoring wells MW-3, MW-5, MW-114, and MW-122 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west-southwest.

Arsenic, barium, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP was detected in monitoring well MW-114 during the first quarter of 1992, and the second quarter of 1993. BEP was not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples collected from 13 sample events conducted from August 1995 to October 2001 were non-detect for all but two events. DBCP, an agricultural contaminant, was detected in a sample collected from monitoring well MW-3 during the fourth quarter 1992 sampling event. This was the only sampling event in which DBCP was analyzed. This detection has been attributed to agricultural fields located up-gradient of the site.

The most recent sampling event at the site was in October 2001. Samples were collected from monitoring wells MW-114 and MW-122. No analytes were detected above laboratory detection limits in MW-122. Trichloroethene, 1,1-dichloroethene and tetrachloroethene were above detection limits but well below applicable water quality standards in MW-114. Methylene chloride was detected in monitoring wells MW-114

and MW-122 during the November 1998 sampling event but was qualified as estimated because it was also detected in the blank. 2-Butanone was also detected in monitoring well MW-114 during this sampling event and was qualified as estimated. MW-114 and MW-122 will be monitored on an annual basis for the next five-year period to evaluate VOC trends, although, no trends are anticipated given the overall monitoring results for the period of record. Samples have not been collected from monitoring wells MW-3 and MW-5 since June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.6 PSC SD-20

PSC SD-20 is located on the southern portion of Luke AFB. Five monitoring wells, MW-102, MW-103, MW-112S, MW-112D, and MW-113, were installed at this site. Monitoring wells MW-102 and MW-103 were installed prior to 1991. Monitoring wells MW-112S, MW-112D, and MW-113 were installed in 1991. The screened intervals in monitoring wells MW-103 and MW-112D have been submerged the majority of the time since installation. The screened intervals in monitoring wells MW-102, MW-112S and MW-113 have not been submerged the majority of the time since installation. Based on 1995 water level measurements, groundwater flow is towards the northwest.

Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP was detected in two samples during the fourth quarter of 1991. BEP was not reported at detectable concentrations in any other sampling events. TCE and DCA were detected in monitoring well MW-113 consistently through the first quarter of 1995. TCE, DCA, PCE, and methylene chloride were detected in monitoring well MW-113 in November 1998. TCE was consistently detected in monitoring well MW-112S through the fourth quarter of 1993. TCE, DCA, PCE, acetone, and methylene chloride were detected in monitoring well MW-112S in November 1998. Since groundwater flow is towards the northwest, the source of these analytes may be attributable to an off-site source rather than the oil/water separator located northeast of the wells. The presence of fissures in this area further complicates the behavior of groundwater. Alternatively, it is possible TCE and other constituents that originated from points on-base that discharged to the oil water separator canal may have migrated to the groundwater. The fissures at the end of the canal may have provided a pathway for these constituents to reach groundwater. The institution of pollution prevention control measures at Luke AFB has eliminated any future potential sources of constituents in this regard. All VOC and BNA

groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and did not satisfy data validation requirements for quantitative data. However, samples from 16 sampling events conducted from August 1995 to May 1999 were non-detect for all but six events.

The most recent sampling event at the site was in May 1999. Samples were collected from monitoring wells MW-112S and MW-113. Bromodichloromethane and chloroform were detected in monitoring well MW-113. No other analytes were detected above laboratory detection limits. Monitoring well MW-112D was last sampled in May 1998. No analytes were detected above laboratory detection limits during this sampling event. Samples have not been collected from monitoring wells MW-102 and MW-103 since June 1996. No analytes were detected above laboratory detection limits during this sampling event. MW-102 and MW-103 have been abandoned. MW-112S, MW-112D and MW-113 will be monitored as part of the next five-year review period.

5.2.7 PSC SD-21

PSC SD-21 is located approximately two miles from Luke AFB south of the WWTP. One monitoring well, MW-101, was installed at this site in 1986. The screened interval has been submerged since installation. Monitoring well MW-101 is still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west.

Arsenic, barium, boron, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP, acetone, and carbon disulfide was detected in one sample during the second quarter of 1994. These analytes were not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from two sampling events conducted from August 1995 to June 1996 were non-detect.

The most recent sampling event at the site was in June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.8 PSC SD-38

PSC SD-38 is located on the eastern portion of Luke AFB. One monitoring well, MW-117, was installed at this site. The screened interval has not been submerged during any of the sampling events. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. The most recent sampling event at the site was in June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.9 PSC SS-42

PSC SS-42 is located in the northeastern portion of Luke AFB. Four monitoring wells, MW-119, MW-120, MW-121, and MW-125, were installed at this site. Monitoring wells MW-119, MW-120, and MW-121 were installed in 1993. Monitoring well MW-125 was installed in 1995. The screened interval has not been submerged during any of the sampling events. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. DCP, a common component of insecticides, was detected in several samples collected from monitoring wells MW-119, MW-120, and MW-121 between November 1993 and February 1995. DCP was again detected in 1997 and 1998 in all four monitoring wells on the site. This data was qualified as estimated. TPH was detected at the site beginning in the first quarter of 1995. BTEX was detected in monitoring well MW-121 in 1997 and 1998. Methylene chloride and PCE were detected in monitoring well MW-121 in 1998. Toluene and methylene chloride were detected in monitoring well MW-120 in November 1998. This data was qualified as estimated. Methylene chloride was detected in monitoring well MW-125 in November 1998. These data were qualified as estimated. All VOC and BNA analyses of groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from 19 sampling events conducted from August 1995 to November 2001 were non-detect for all but five events.

The most recent sampling events at the site were in August and November 2001. Samples were collected from monitoring well MW-121 and a replacement to well MW-125 designated, as MW-125R MW-125 had to be replaced because the casing had collapsed. The well that collapsed had steel casing. The deterioration of the steel casing is attributed to the reactivity of the steel with the underlying geologic materials. No analytes were detected above laboratory detection limits. Monitoring well MW-119 was last sampled in July 1997. DCP was detected above laboratory detection limits during this sampling event. Monitoring well MW-120 was last sampled in November 1998. DRO, DCP, methylene chloride, and toluene were detected above laboratory detection limits during this sampling event. MW-119 and MW-120 have collapsed due to corrosion and are scheduled to be abandoned. MW-121 and MW-125 are still active and will be monitored as part of the next five-year review.

6.0 Investigative Site History

This section of the five-year review report provides a historical and five year review process summary for OU-1 and OU-2 PSCs for which remedies were selected. The five-year review process primarily consisted of a site inspection, interviews and a review of relevant documents and data. The five-year review for the site was led by Jeff Rothrock of Luke AFB. The following team members assisted in the review:

- Jon Sherrill, ARCADIS G&M, Inc.
- Kent Lang, ARCADIS G&M, Inc.
- Stephanie Armijo, ARCADIS G&M, Inc.
- Nichole Cherry, ARCADIS G&M, Inc.
- Monique Ostemann, USACE
- Greg Mellema, USACE
- Dan Stralka, USEPA
- Nancy Lou Minkler, ADEQ

6.1 Five Year Review Process Summary

The five-year review process includes the following primary elements:

- Remedy selection and implementation is reviewed and summarized for each OU-1 and OU-2 PSC for which a remedy was selected.
- Changes in standards were evaluated with respect to the continued effectiveness of the remedies that were implemented based on cancer risks and

non-cancer hazards for applicable COCs for Base worker or excavation worker scenarios.

- Groundwater monitoring results are compared to groundwater standards established for the project.
- Representatives of Luke AFB, USEPA, US Army Corps. of Engineers, ADEQ and ARCADIS G&M performed a site inspection of each PSC for which a remedy was selected on May 22, 2001.
- The results of interviews with individuals knowledgeable about the project.

6.2 Review of OU-1 PSCs

OU-1 PSCs for which there was no action taken (refer to discussion in Section 1.1.3 and information in Table 3-2) include the following:

- OT-01
- OT-08
- OT-09
- OT-10
- SS-15
- SS-16
- SS-19
- SD-21
- DP-24
- SD-26
- LF-37
- SD-39
- OT-41

A comparison of the EPC for a given COC in the combined surface and subsurface soil, with USEPA Region IX industrial PRGS (1996 and 2000) and ADEQ residential and non-residential SRLs is in Appendix C. EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution unless indicated otherwise.

OU-1 PSCs for which remedies were selected based on the results of risk assessment include the following:

- RW-02
- LF-03

- FT-07
- DP-13
- LF-14
- LF-25
- SD-38
- SS-42

For OU-1 PSCs, PRGs were not established. Alternatively, PSC specific cancer risks and non-cancer hazards were calculated using 1996 USEPA Region IX PRG guidance to develop a site-specific industrial scenario. To evaluate changes in standards as part of this five-year review, cancer risk and non-cancer hazards were recalculated using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable (USEPA Region IX PRGs for 1996 and 2000 are in Appendix D). EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution, or from the maximum concentration for PSCs with post-remediation data in surface soils for the base worker and in all soils collected to a depth of 16 feet bgs for excavation workers. ADEQ SRLs were also reviewed since they were used to determine risk under a residential land use scenario.

Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of 1×10^{-6} to 1×10^{-4} .

6.2.1 PSC RW-02 Wastewater Treatment Annex

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD²⁷, the remedy selected for PSC RW-02 consisted of institutional controls listed as follows:

²⁷ ARCADIS Geraghty & Miller, Inc., 1999. Final Record of Decision, Operable Unit 1, Luke AFB, Arizona, January 20, 1999.

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.
- Geophysical monitoring conducted annually for 30 years to ensure safety of potential receptors and to provide a warning mechanism in case of a change in subsurface conditions.
- Perimeter fencing installed around the low-level waste containment structure to provide a physical barrier.

Remedy Implementation

The establishment of PSC RW-02 was part of overall remediation of an associated landfill and bank stabilization for the Agua Fria River. The implementation of the remedy for PSC RW-02 is summarized as follows:

- A VEMUR was placed on the radiological waste portion of the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- An ICP²⁸ was prepared and implemented as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and described the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.
- Four monitoring points were installed to a depth of 20 feet in December 1999. According to the monitoring plan²⁹, radiological logging will be conducted on an annual basis at the three monitoring points for a period of 30 years. The third annual radiological monitoring event was conducted on August 8, 2001.

²⁸ ARCADIS Geraghty & Miller, Inc., 2000. Institutional Control Plan, Luke Air Force Base, Arizona, December 15, 2000.

²⁹ ARCADIS Geraghty & Miller, Inc., 2000. Long Term Radiological Monitoring Plan. November 14, 2000.

The background levels for soil in the area were measured at 11,558 through 19,618 counts per minute (cpm). The radiological levels for all four measuring points were between 10,310 and 20,434 cpm. These results are similar to background levels, indicating that the soil surrounding the buried radiological waste has not been impacted and the radiological waste containment structure remains protective.

System Operation and Maintenance

No operation and maintenance was required for the remedy selected. The cost of the remediation at PSC RW-02 to date has been \$23,560. The annual monitoring is expected to cost \$2,000.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

No change in land use had occurred since implementation of the remedy for the site. Stabilization work conducted on the Aqua Fria River as part of remediation of a former landfill at the site was also inspected and discussed. Photographs of PSC RW-02 taken during the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations (taken to be the maximum detected concentration within the soil profile considered) in surface soils and USEPA Region IX PRGs for a base worker and soils to a depth of 16 feet bgs and USEPA Region IX PRGs for an excavation worker are in Tables 6-1 and 6-2, respectively. The comparison indicates that exposure to constituents detected at PSC RW-02 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics, with the exception of beryllium. Beryllium was reclassified by USEPA for risk assessments as non-carcinogenic based on the types of exposure. This difference can be seen in a comparison of the 1996 PRGs and the 2000 PRGs.

Data Evaluation

TRPH was detected to a depth of ten feet in the test pit with the highest concentration at 4,100 mg/kg. TRPH was detected in all eight-soil borings advance in 1993. Radiochemical results indicated that concentrations were consistent with natural soils. Additional soil borings were advance in 1996. BNAs were detected to a depth of 16 feet. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 2×10^{-7} and 0.6, respectively³⁰. Based on the results of the risk assessment, COPCs identified at PSC RW-02 were not present in concentrations high enough to cause adverse health effects under industrial or residential land use. However, the decision to use institutional controls was based on the presence of the low-level radioactive waste containment structure limits potential future land usage.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent exposure to radioactive material and to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

³⁰ Geraghty & Miller, 1997. Final Remedial Investigation Report OU-1, Appendix B – Baseline Base wide Risk Assessment, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1 1997.

Insert Table 6-1

Insert Table 6-2

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

MW-124 will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC RW-02 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.2 PSC LF-03 Outboard Runway Landfill

Remedial Actions

Remedy Selection

As stated in the OU-2 ROD, the remedial action selected for PSC LF-03 consisted of institutional controls list as follows:

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.

Remedy Implementation

The implementation of the remedy for PSC LF-03 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.

- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- The ICP was incorporated as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-03 was \$347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

No changes in land use since implementation of the remedy for the site were observed during the inspection. Photographs of PSC LF-03 taken during the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-3 and 6-4, respectively. The comparison indicates PSC LF-03 is still within the acceptable risk range.

Insert Table 6-3

Insert Table 6-4

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the ELCR for chromium concentrations at the site of 5×10^{-6} , above the allowable residential risk of 1×10^{-6} . The elevated ELCR for chromium was caused by two samples with high chromium concentrations collected at test pit TP-5. The risk assessment used the conservative assumption that all of the chromium was in the hexavalent state.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

There are no further recommendations or follow-up activities suggested at this time.

Protectiveness Statement

The remedy at PSC LF-03 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.3 PSC FT-07E Eastern Portion of North Fire Training Area

Remedial Actions

Remedy Selection

A SVE system was installed in 1992 at a cost of \$395,000 and was done independent of the OU-I ROD. The system was operational from April 1992 through December 1992 and approximately 14,000 pounds of contaminants were removed. During the RI, an investigation was conducted to determine the effectiveness of the removal. The conclusions of the investigation were that the SVE effectively removed contaminants greater than 16 feet bgs. However, high levels of contaminants still remained in the shallow soils. As stated in the OU-1 ROD, and based on the risk assessment for the shallow soils, the remedial action selected for PSC FT-07E consisted of institutional controls. Institutional controls at PSC FT-07E consisted of the following:

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.

Remedy Implementation

The implementation of the remedy for PSC FT-07E is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- The ICP was incorporated as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.

- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC FT-07E was \$347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use at the site since implementation of the remedy was observed. Photographs of PSC FT-07E taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-5 and 6-6, respectively. The comparison indicates that PSC FT-07E is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Insert Table 6-5

Insert Table 6-6

Data Evaluation

The determination to have no remedial action at the site was based on the results of soil sampling conducted as part of the RI. Soil samples collected in 1991 had concentrations of TRPH ranging up to 3,800 mg/kg. Lead was detected above the background UTL. The highest concentration was 172 mg/kg. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 4×10^{-8} and 0.0002, respectively. The vadose zone transport model also indicated that the COCs would not migrate to and impact groundwater. Due to TPH concentrations, residential land use is restricted through a VEMUR.

Assessment

Is the remedy functioning as intended by decision documents?

The remedial action is functioning as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

MW-118 and MW-123 will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC FT-07E is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.4 DP-13 Drainage Ditch Disposal Area

Remedial Actions

Remedy Selection

As stated in the ROD for OU-1, institutional controls were the selected remedy for PSC DP-13. Institutional controls implemented at PSC DP-13 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC DP-13 is summarized as follows:

- A VEMUR was implemented at site on June 15, 2000, to restrict residential development. The BGP was revised on January 5, 2000, to restrict residential development and to require the use of PPE by workers in the event soils are excavated at the site.
- An Institutional Control Plan was implemented on December 15, 2000, which was designed to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP included provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the selected remedy. The cost of the institutional controls implemented at PSC DP-13 was \$347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

During the inspection, the feasibility of removing landfill materials at some future date was raised as an issue. There were no other comments. No changes in land use had occurred since implementation of the remedy for the site. Photographs of PSC DP-13 taken as part of the inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-7 and 6-8, respectively. The comparison indicates that PSC DP-13 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the ELCR at the site of 3×10^{-5} , which is greater than the allowable residential risk of 1×10^{-6} , and the HI of 2, which is greater than the allowable residential risk of 1. The risk assessment assumed that all of the chromium was in the hexavalent state. Mean blood lead levels for sensitive populations that included children up to seven years old, were calculated using the IEUBK model. The predicted blood lead level for exposure to subsurface soils at PSC DP-13 were 21.4 $\mu\text{g}/\text{dL}$, which exceeds the concern limit of 10 $\mu\text{g}/\text{dL}$.

Insert Table 6-7

Insert Table 6-8

The elevated ELCR and HI values for chromium and blood level values predicted by the IEUBK model were the result of one sample with elevated chromium concentrations (15,900 mg/kg) and lead concentrations (36,000 mg/kg) collected from test pit TP-12. The elevated concentrations of chromium were attributed to a paint pail and dried paint observed in this test pit. The paint pail and dried paint was removed from the test pit.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

There are no further recommendations or follow-up activities suggested at this time.

Protectiveness Statement

The remedy at PSC DP-13 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.5 PSC LF-14 Old Salvage Yard Burial Site

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC LF-14 consisted of institutional controls. Institutional controls implemented at PSC LF-14 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC LF-14 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-14 was \$347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC LF-14 taken as part of the site inspection are in Appendix E.

Changes in Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker, and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-9 and 6-10, respectively. The comparison indicates that PSC LF-14 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Insert Table 6-9

Insert Table 6-10

Data Evaluation

The determination to use institutional controls was based on the ELCR at the site of 3×10^{-5} , above the allowable residential risk of 1×10^{-6} . The elevated ELCR was caused by two samples with high chromium concentrations. The risk assessment used the conservative assumption that all of the chromium was in the hexavalent state. Additionally high concentrations of PCBs elevated the ELCR. The highest concentration of PCBs was found at 20 feet bgs. Because exposure to soils beneath 16 feet bgs is not likely concentration of PCBs detected below 16 feet were not used in calculating the ELCR.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC LF-14 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.6 PSC LF-25 Northwest Landfill

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC LF-25 consisted of the following:

- Ex-situ physical treatment/metals recovery
- Institutional controls

Remedy Implementation

Implementation of ex-situ physical treatment/metals recovery at PSC LF-25 is summarized as follows:

- Shot recovery activities, conducted from December 16-19, 1999³¹, included removal of surficial soil from an area approximately 375 feet by 375.
- The soil was fed into a metal recovery processor, which sorted out the metal shot and returned that soil to the ground.
- Approximately 2,800 pounds of shot was recovered.
- Confirmation sampling was conducted to ensure that site remediation was effective.
- The analytical results showed that all soil samples were below the residential SRLs of 31 mg/kg for antimony and 400 mg/kg for lead.

Implementation of institutional controls at PSC LF-25 is summarized as follows:

³¹ ARCADIS Geraghty & Miller, Inc., 2000. Shot Recovery Summary Report for PSC LF-25, June 1, 2000.

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-25 was \$347. The cost of the ex-situ physical treatment/metals recovery was \$42,985.

Progress Since the Last five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC LF-25 taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for Base and excavation worker is in Table 6-11. The comparison indicates that PSC LF-25 is still within the acceptable risk range.

Insert Table 6-11

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to implement institutional controls was based on failed site-specific industrial risk standards that was a result of one sample with high antimony concentrations. This sample contained a piece of metal shot, resulting in the high concentration of antimony. The metal shot came from the nearby skeet range. Removal of the metal shot from the site was conducted in December 1999 and subsequent soil sampling indicated that soil levels were below residential SRLs³¹. Since no carcinogens were identified as COCs, an ELCR was not calculated for the site.

Mean blood lead levels for sensitive populations, children up to seven years old, were calculated using the IEUBK model. The predicted blood lead level for exposure to subsurface soils at LF-25 was 14.5 µg/dL. This is above the limit of 10 µg/dL. The high concentration of lead in one sample (10,100 mg/kg) elevated the predicted blood lead level. This sample contained a piece of metal shot, resulting in the high concentration of lead. The metal shot came from the nearby skeet range. Removal of the metal shot from the site was conducted in December 1999, and subsequent soil sampling indicated that soil levels were below residential SRLs. Even though antimony and lead concentrations are below residential SRLs, institutional controls (VEMUR) are still required because the site is still utilized as an active skeet range and there is still a potential source of these metals.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended. Removal of the metal shot from the site was conducted in December 1999, and subsequent soil sampling indicated that soil levels were below residential SRLs³¹.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC LF-25 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.7 PSC SD-38 Southwest Oil/Water Separator at the Auto Hobby Shop

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC SD-38 consisted of institutional controls. Institutional controls implemented at PSC SD-38 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of PPE while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC SD-38 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC SD-38 was \$347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC SD-38 taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-12. The comparison indicates PSC SD-38 is still within the acceptable risk range.

Insert Table 6-12

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the HI, which was above the allowable residential risk of 1.0. The elevated HI was caused by several samples with high TRPH concentrations.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC SD-38 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.8 PSC SS-42 Bulk Fuels Storage

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC SS-42 consisted of the following:

- Soil vapor extraction
- Groundwater monitoring

Remedy Implementation

Implementation of the remedial action selected for PSC SS-42 is summarized as follows:

- In August 1996, the Base initiated a SVE removal action at PSC SS-42.
- A highly modified ICE was used to draw contaminated vapors from the ground and to treat the off-gas prior to discharge.
- The SVE removal action continued through November 1998.
- In June 1997, an initial confirmation boring was advanced to a depth of 181 feet bgs near the former UST location.
- The analytical results indicated that BTEX and TPH had been decreased in the subsurface. However, the results also indicated that BTEX was detected at depths below 150 bgs at concentrations higher than they had been originally detected.
- A second confirmation boring, located approximately eight feet northwest of monitoring well MW-121, was advanced to a depth of 310 feet bgs.
- TPH and benzene were detected above their respective residential SRLs. Benzene was also detected above the industrial SRLs. Toluene, ethylbenzene,

and total xylenes were detected in several samples but below their respective SRLs³².

- Analytical data indicates that SVE operation has removed approximately 399, 514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87%.
- Although benzene was detected above the AWQS during the November 1998 groundwater sampling event, the May 1999, May 2000 and August 2001 samples did not contain benzene above laboratory detection limits.
- Groundwater monitoring has continued at the site³².

System Operation and Maintenance

Operation and maintenance was performed monthly during operation of the SVE. This included sampling, field measurements, readings from the system, and engine service. Also, any problems with the system between monthly visits were addressed as needed. The cost of the operation and maintenance was \$65,910. There was no cost for remediation because the internal combustion engine (ICE) was provided to Luke AFB without charge by AFCEE.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC SS-42 taken as part of the site inspection are in Appendix E.

³² ARCADIS Geraghty & Miller, Inc. 2000. Soil Vapor Extraction and Confirmation Sampling Summary Report, PSC SS-42, May 22, 2000.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-13. The comparison indicates that PSC SS-42 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

Based on the laboratory analysis of soil samples collected from confirmation soil boring number 2 (CB-2), detected TPH concentrations in the soil directly beneath the former Leaking Under Storage Tank (LUST) range from 250 to 7,400 mg/kg. With the exception of the 7,400 mg/kg concentration, all other detected TPH values are below the residential SRL of 4,100 mg/kg. The TPH concentration of 7,400 mg/kg is above the residential SRL but below the non-residential SRL of 14,000 mg/kg. Detected benzene concentrations ranged from 0.23 to 150 mg/kg. The benzene concentrations detected at 140 feet bgs (150 mg/kg) and 150 feet bgs (2.5 mg/kg) were above both the residential SRL (0.62 mg/kg) and non-residential SRL (1.4 mg/kg), respectively. Detected toluene concentrations were below both the residential SRL (790 mg/kg) and the non-residential SRL (2,700 mg/kg), respectively. Detected ethylbenzene concentrations were below both the residential SRL (1,500 mg/kg) and the non-residential SRL (2,700 mg/kg), respectively. Detected total xylenes concentrations were below both the residential (2,800mg/kg) and non-residential SRL (2,800mg/kg). Analytical data indicates that SVE operation has removed approximately 399,514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87 percent. Although benzene was detected above AWQSs during the November 1998 groundwater-sampling event, the May 1999, May 2000 and August 2001 samples did not contain benzene above laboratory detection limits. Groundwater monitoring has continued at the site³².

Insert Table 6-13

Groundwater Protection Level (GPL) Modeling

As detailed in the ROD, vadose zone fate-and-transport modeling was previously conducted at the site during the OU-1 remedial investigation¹³. Results of this modeling indicate that petroleum related compounds (i.e. TPH and BTEX) could eventually leach to the groundwater. However, the vadose zone modeling results conducted as part of the OU-1 remedial investigation did not predict whether these petroleum related compounds could cause a violation of the AWQS at a point of compliance. As a result, groundwater protection levels (GPLs) had not been previously established for the site. GPLs could not be calculated for TPH because there are no numeric water quality standards established for TPH. GPLs can only be calculated for individual constituents with AWQSs. Of the petroleum-related constituents with established AWQSs detected at the site, BTEX compounds posed the greatest potential risk to human health. For these reasons, GPLs calculated for BTEX are considered representative values established for the protection of groundwater from the petroleum release at the site.

As a consequence of the limited depth of incorporation range presented in the ADEQ “Alternative GPL” tables, a site-specific model had to be used to determine GPLs for the site. The ADEQ screening model was selected for use in this evaluation. Several model runs were conducted using varying depths of incorporation and varying depths to groundwater. These additional runs were conducted so that GPLs could be established for a variety of potential site conditions in the event confirmation sampling at the site yields a different depth of incorporation and depth to groundwater than indicated by previously collected site characterization data. The results of the additional modeling runs are summarized below:

- GPLs calculated for benzene ranged from 8,685 mg/kg (180.45 ft depth of incorporation and 295.28 ft depth to groundwater) to 400,600 mg/kg (180.45 ft depth of incorporation and 328.10 ft depth to groundwater).
- GPLs calculated for the ethylbenzene ranged from 679 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.
- GPLs calculated for toluene ranged from 35,310 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.
- GPLs calculated for xylenes ranged from 23,580 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.

Concentrations of BTEX remaining in the soils are protective of groundwater. Analytical results and the GPL model also indicate that remediation has decreased hydrocarbon concentrations to this protective point and further remediation is not needed. However, because constituents of concern were detected at a depth of 140 feet bgs, it was prudent to conduct groundwater monitoring.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action was to clean up impacted soil and prevent migration to groundwater. Analytical data indicates that SVE operation has removed approximately 399,514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87 percent. TPH and BTEX were not detected above laboratory detection limits during the most recent groundwater results.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered as part of this five-year review.

Recommendations and Follow-up Activities

MW-121 and MW-125R will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC SS-42 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.3 Review Process for OU-2 PSCs

OU-2 PSCs for which there was no action taken (refer to discussion in Section 1.1.3 and information in Table 3-1) include the following:

- OT-04
- DP-05
- FT-06
- FT-07W
- DP-22
- SD-40

A comparison of the EPC for a given COC in the combined surface and subsurface soil, with USEPA Region IX industrial PRGs (1996 and 2000) and ADEQ residential and non-residential SRLs is in Appendix C. EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution.

OU-2 PSCs for which remedies were selected based on the results of risk assessment include the following:

- ST-18
- DP-23

For OU-2 PSCs, 1991 USEPA Region IX PRGs were originally used to establish performance standards. To evaluate changes in standards as part of this five-year review, cancer risks and non-cancer hazards were recalculated for each COC using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for Base worker and excavation worker scenarios as applicable. The analysis of standard changes also included a review of 1996 USEPA industrial PRGs. ADEQ SRLs were also reviewed since they were used to evaluate residential use standards. USEPA Region IX PRGs for 1991, 1996 and 2000 are in Appendix D. Changes in standards are evaluated with respect to the continued effectiveness of the

remedies that were implemented based on a non-cancer HI greater than or equal to 1.0 or an ELCR greater than the risk of 1×10^{-6} to 1×10^{-4} .

6.3.1 PSC ST-18 Facility 993

Remedial Actions

Remedy Selection

As stated in the OU-2 ROD, the remedy selected for PSC ST-18 consisted of the following:

- Inspection and maintenance of concrete cap
- Institutional controls
- Monitoring of groundwater every five years

Remedy Implementation

The implementation of the remedy for PSC ST-18 is summarized as follows:

- The site was capped with nine inches of concrete, underlain by six inches of base course and a 30-mil HDPE liner as part of the RCRA closure requirement in 1987.
- The integrity of the cap has been maintained through annual inspections of the concrete and joints and repairs as needed in accordance with the Air Force design guidance for airfield pavement maintenance and recommendations contained in the annual inspection report. Annual inspection reports are maintained at the Environmental Flight office of Luke AFB. A visual inspection was conducted in August 2000 and the need for some repairs was identified. Recommended repairs were performed in August 2001. The annual inspection report dated October 2001 documents the successful completion of repairs.
- According to the ROD, a deed restriction would be placed on the site as part of the surface controls to prevent removal of the cap and excavation of the soil. A DEUR has been filed with the ADEQ for this site.
- The other surface control at the site is the Base perimeter fence monitored 24-hours a day which prevents public access and exposure.

- Groundwater at the site has been monitored semiannually since 1991. A review of the site data was conducted in 2000 and it was concluded that groundwater monitoring was not necessary at the site³³.
- The FCOR states that groundwater monitoring will be conducted at the site as part of each five-year review. Well MW-114 was monitored in October 2001 as part of the five-year review process. No constituents exceeded standards in the sample from MW-114.

System Operation and Maintenance

Operation and maintenance has included annual inspections of the cap. The integrity of the cap has been maintained through annual inspections of the concrete and joints and repairs have been conducted as needed in accordance with the Air Force design guidance for airfield pavement and maintenance and recommendations contained in the annual inspection reports. The cost of the cap in 1987 was \$122,300. The annual cap inspection is \$2,500. To date, the costs of repairs to the cap have been \$12,118. An additional \$3,880 in repairs is scheduled for 2001.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

Comments made during the site inspection of PSC ST-18 are noted under recommendations and follow-up activities below. No changes in land use were observed since implementation of the remedy. Photographs of PSC ST-18 taken as part of the site inspection are in Appendix E.

³³ Geraghty & Miller, Inc., 2000. RCRA Facility Investigation Summary Report Facility #993 (PSC ST-18), Luke Air Force Base, Arizona, December 19, 2000.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-14. The comparison indicates that PSC ST-18 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Insert Table 6-14

Data Evaluation

Soil samples collected in 1992 had concentrations of TRPH ranging up to 17,000 mg/kg. BTEX, 1,1-DCA, 1,1,2,2-tetrachloroethane, TCE, and PCE were also detected. Lead was detected above the background UTLs. The highest concentration of lead was 32 mg/kg. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 3×10^{-6} and 0.1, respectively. The purpose of the institutional controls at the site are to ensure the integrity of the concrete cap.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action was to prevent exposure to the contaminated soil. By maintaining the integrity of the cap, implementing surface controls, and continuing groundwater monitoring, the remedy is functioning as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

According to the ROD, a deed restriction should be placed on the site as part of the institutional controls to prevent removal of the cap and excavation of the soil. A Declaration of Environmental Use Restriction (DEUR) for PSC ST-18 has been filed with the ADEQ.

Recommendations and Follow-up Activities

The following are the recommendations or follow-up activities suggested at this time:

- According to the ROD, a deed restriction needs to be placed on the site as part of the institutional controls. A DEUR has been filed with the ADEQ to restrict residential land use in the future.
- As part of the inspection, it was noted the concrete cap is in good condition and is well maintained by Luke AFB and that maintenance of cracks in the concrete is less critical given the presence of the geomembrane layer. The cap will continue to be inspected annually.
- MW-114 and MW-122 will be monitored annually for VOCs and the results evaluated as part of the next five-year review.

Protectiveness Statement

The remedy at PSC ST-18 Facility 993 currently protects human health and the environment because the cap prevents exposure in the short term. However, in order for the remedy to be protective in the long term, a DEUR will be placed at the site to ensure long-term protectiveness. In addition, MW-114 and WM-122 will be monitored for VOCs and evaluated as part of the next five-year review.

6.3.2 PSC DP-23 Old Surface Impoundment West of Facility 993

Remedial Actions

Remedy Selection

In accordance with the OU-2 ROD, the selected remedy for the southern portion of PSC DP-23 consisted of the following:

- Excavation
- Ex-situ biological treatment
- On-site disposal
- Monitoring

The selected remedy for the northern portion of PSC DP-23 was no action.

Remedy Implementation

Southern Portion of PSC DP-23

The implementation of the remedy for the southern portion of PSC DP-23 is summarized as follows:

- In 1995, a preliminary soil survey was conducted by Environmental Chemical Corporation (ECC) to determine the exact extent of the impacted soil³⁴.
- Based on the results of the preliminary survey, the USACE requested a more detailed site characterization.
- Additional samples were collected and ECC used the results to determine the area for excavation.
- ECC constructed berms to contain impacted soil and divert surface runoff away from the excavation areas.
- An on-site containment cell was constructed and lined with a 40 mil HDPE liner and topped with approximately six inches of native soil to protect the liner.
- ECC excavated 625 cubic yards of soil, which was transferred to the containment cell.
- The soil was mixed with alfalfa, manure, wood chips and green waste according to ratios established by Woods End Research Laboratory during computer optimization studies to form a compost.
- Composite samples were collected to determine the baseline levels of benzo(a)pyrene.
- The soil was tilled and watered and monitored daily for temperature, oxygen, and moisture content.
- Interim sampling was conducted after the compost had been processed for 60 days from the same locations as the baseline samples with a final sampling event was conducted after 120 days.
- The interim sample results indicated one quarter of the soil remained above PRGs.
- The soil was composted for an additional 60 days.

³⁴ Environmental Chemical Corporation, 1997. Closure Report, Site DP-23, Soil Composting at Luke Air Force Base, Arizona, August 27, 1997.

- Samples collected after the additional 60 days of composting indicated benzo(a)pyrene concentrations were below PRGs.
- Upon completion of the remediation, the site was restored to its original condition and the liner was disposed at a local landfill.
- The PAH concentrations were compared to analytical detection limits and not PRGs. This was done because the evaluation of risk determined that the risk associated with the higher concentrations was acceptable based on the potential for exposure of a base worker or construction worker to PAH at DP-23 south.
- The site was closed based on completion of remediation

Northern Portion of PSC DP-23

While the extent of impacted soil was being determined for the southern portion of the site it became apparent that the contamination extended northward. The implementation of the remedy for the northern portion of PSC DP-23 is summarized as follows:

- In 1996, Dames & Moore performed a risk-based assessment for the northern portion of PSC DP-23 based on two rounds of soil sampling conducted to characterize soil impacts at the site³⁵ and the results of samples collected by ECC in 1995. The extent of contamination to the north was never fully determined due to the tarmac at the northern most reaches of the site. Due to mission impact, no samples were collected from under the tarmac.
- Dames & Moore used the 1996 EPA Region IX PRG tables for soil to calculate the potential risk. Dames & Moore concluded that over the entire extent of the site, the predicted risk associated with exposure to carcinogens from PAHs in the surface soil was 1×10^{-5} and that predicted risks associated with exposure to subsurface soils ranged from 6×10^{-6} to 2×10^{-5} .
- These risks calculated by Dames & Moore were within the acceptable range of 1×10^{-6} to 1×10^{-4} for industrial sites according to EPA and ADEQ standards.
- Although Dames & Moore did not recommend soil remediation, they did recommend a VEMUR be implemented on the site.
- In 2001, a DEUR was filed with the ADEQ.

³⁵ Dames & Moore, 1998. Final Site DP-23 Phase II Remedial Design Report, Luke Air Force Base, Arizona, April 1998.

System Operation and Maintenance

No operation and maintenance was required for the remedy selected. Remedial costs for the southern portion of PSC DP-23 were \$735,805. The cost of the risk-based assessment for the northern portion of PSC DP-23 was \$149,159.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Findings

Site Inspection

There were no comments during the site inspection of PSC DP-23. No changes in land use were observed since implementation of the remedy. Photographs of PSC DP-23 taken as part of the site inspection are in Appendix E.

Changes to Standards

Southern Portion of PSC DP-23

A comparison of exposure point concentrations in sub-surface soils utilizing post-remediation data and USEPA Region IX PRGs is in Tables 6-15. The comparison indicates the southern portion of PSC DP-23 is within the acceptable risk range.

Northern Portion of PSC DP-23

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRG's for a base worker and surface and sub-surface soils and USEPA Region IX PRG's for an excavation worker are in Tables 6-16 and 6-17, respectively. The comparison indicates the northern portion of PSC DP-23 is within the acceptable risk range for industrial land use and outside the acceptable risk range for residential land use. A DEUR for this portion of the site has been filed with the ADEQ to provide long-term protectiveness.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

Southern Portion of PSC DP-23

The impacted soil at the site was remediated. Post-remediation soil samples collected from the walls and floors of the excavation indicate the site has been remediated to residential standards.

Insert Table 6-15

Insert Table 6-16

Insert Table 6-17

Northern Portion of PSC DP-23

No remedial action was performed on this site. A risk-based assessment was conducted by Dames & Moore³⁶ and concluded that the potential risk from exposure to the carcinogenic PAHs was between 1×10^{-6} and 1×10^{-4} . The potential risk meets the acceptable ranges for industrial sites but does not meet the acceptable limit for residential sites. Therefore, a DEUR should be implemented on the site. The risk-based assessment used 1996 PRGs, which are more stringent than the 2000 PRGs.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action established in the OU-2 ROD was to clean up impacted soil in the southern portion of PSC DP-23. Since the soil was successfully remediated to residential standards, the remedy is considered protective.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

The northern portion of PSC DP-23 requires a DEUR to provide long-term protectiveness.

³⁶ Dames & Moore, 1998. Final DP-23 Phase II Remedial Design Report, Luke Air Force Base, Arizona.

Recommendations and Follow-up Activity

The following are the recommendations or follow-up activities suggested at this time:

- A DEUR needs to be finalized for the northern portion of PSC DP-23 since the site was not remediated to residential standards.

Protectiveness Statement

The remedy for the southern portion of PSC DP-23 is protective of human health and the environment. To ensure conditions for the northern portion of PSC DP-23 are protective of human health and the environment in the long-term, a DEUR has been filed with the ADEQ.

6.4 Groundwater Review

A comparison of exposure point concentrations in groundwater (maximum concentrations for the period of record) and USEPA Region IX 2000 PRGs for tap water and ADEQ aquifer water quality standards are in Tables 6-18 through 6-26, respectively, for the following PSCs:

- RW-02
- DP-05
- FT-06
- FT-07
- ST-18
- SD-20
- SD-21
- SD-38
- SS-42

The comparison indicates groundwater is within the acceptable risk range for applicable PSCs.

Insert Table 6-18

Insert Table 6-19

Insert Table 6-20

Insert Table 6-21

Insert Table 6-22

Insert Table 6-23

Insert Table 6-24

Insert Table 6-25

Insert Table 6-26

6.5 Interviews

The following individuals were solicited for interviews by questionnaire as part of this five-year review:

- Belle Matthews, Luke AFB Project Manager
- Sean Hogan, EPA Project Manager
- Nancy Lou Minkler, ADEQ Project Manager
- Dan Salzler, Citizens Advisory Board (CAB) Community Co-Chairperson
- Joyce Clark, CAB member
- Martin Jeffries, CAB member

The only individuals who responded to the questionnaire were Belle Matthews, Nancy Lou Minkler and Martin Jeffries. Interview results for these individuals are in Appendix F.

In addition to solicitation of interviews by questionnaire, the following individuals were interviewed in person as part of the May 22, 2001 site inspection:

- Chris Christoffer, Luke AFB Environmental Analyst
- Sergeant Anthony Michels, Luke AFB Infrastructure Superintendent

Chris Christoffer and Sergeant Michels were interviewed relative to procedures that ensure compliance with the BGP and ICP. As part of these interviews, the BGP was reviewed and it was verified that the ICP had been implemented. Also verified were approval and record keeping procedures for digging permits relative to environmental constraints at Luke AFB.